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Summer 1975

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issues · choices · actions
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200 CANDLES 50 STARS

On 16 June 1975, the United States Army Corps of Engineers celebrated its Bicentennial birthday—200 years of dedicated service to our Nation.

Traditionally, the Corps traces its beginning to that date in 1775 when the Continental Congress authorized a Chief Engineer for General Washington's Grand Army. Historically, the birth date of the Corps is barely more significant than March 16, 1802, the day President Jefferson signed a bill directing the Engineers to "constitute a military academy" at West Point, the first engineering school in the United States. For many years Academy graduates were the only sizable group of trained engineers in the young republic.

In the first quarter of the 19th Century, as demands for internal improvements rose, the Federal Government turned to the Engineers. Piers and lighthouses, roads and canals, surveys and explorations—their early activities encompassed all of these. From 1824 onward, Congress assigned the Corps increasing responsibilities for planning and execution of navigation, flood control, hydroelectric power, and related projects. A $20 billion civil works effort, spanning over 150 years, developed the world's best inland waterway system, harbors encircling the nation, protection from floods, and far-reaching benefits in power production, water supply for people and industry, recreation and environmental enhancement for fish and wildlife.

The soundness and value of the Corps' civil projects and its flawless record for integrity in handling public funds earned the confidence of the people, the Congress, and successive Presidents of the United States.

The extensive experience gained from these civil endeavors proved to be extremely valuable for our country in time of war and military annals are filled with the exploits of Army Engineers. Saratoga, Yorktown, Chippewa, Lundy's Lane, Vera Cruz, Chapultepec—148 battle streamers adorn the Corps colors.

The defense of Washington and bridging of the James in the Civil War; the Siege of Santiago in 1898; vast port, depot, road and railroad work in France in World War I; building the Ledo Road in Burma and Alaska Highway, amphibious landings on many shores, construction support of American air power, speedy restoration of demolished ports, and spanning the Rhine in World War II; the build-up at Pusan in Korea; and creation of the great port at Cam Ranh Bay in Viet Nam furnish examples of Engineer soldiers in their traditional roles —impeding enemy advances and assisting the movement of friendly troops. On occasion, as at Cambrai in 1918, Milne Bay in 1942, and Kasan in 1950, Engineers fought as infantry. Engineer officers, experienced in large-scale peacetime undertakings, were especially well-fitted for high command and staff positions. Generals Robert E. Lee and Douglas MacArthur epitomize the Engineer commander. And in the Nation's three major conflicts, the Army's top logisticians were Engineers: Generals Montgomery C. Meigs in the Civil War, George W. Goethals in World War I, and Brehon B. Somervell in World War II.

In the new age of mass armies and swiftly advancing technology, warfare is more and more an engineering operation. World War II, by frequent definition, was "an Engineers' War." In this conflict, Engineer troops accounted for 11 percent of ground and air forces in Europe and for 13 percent in the

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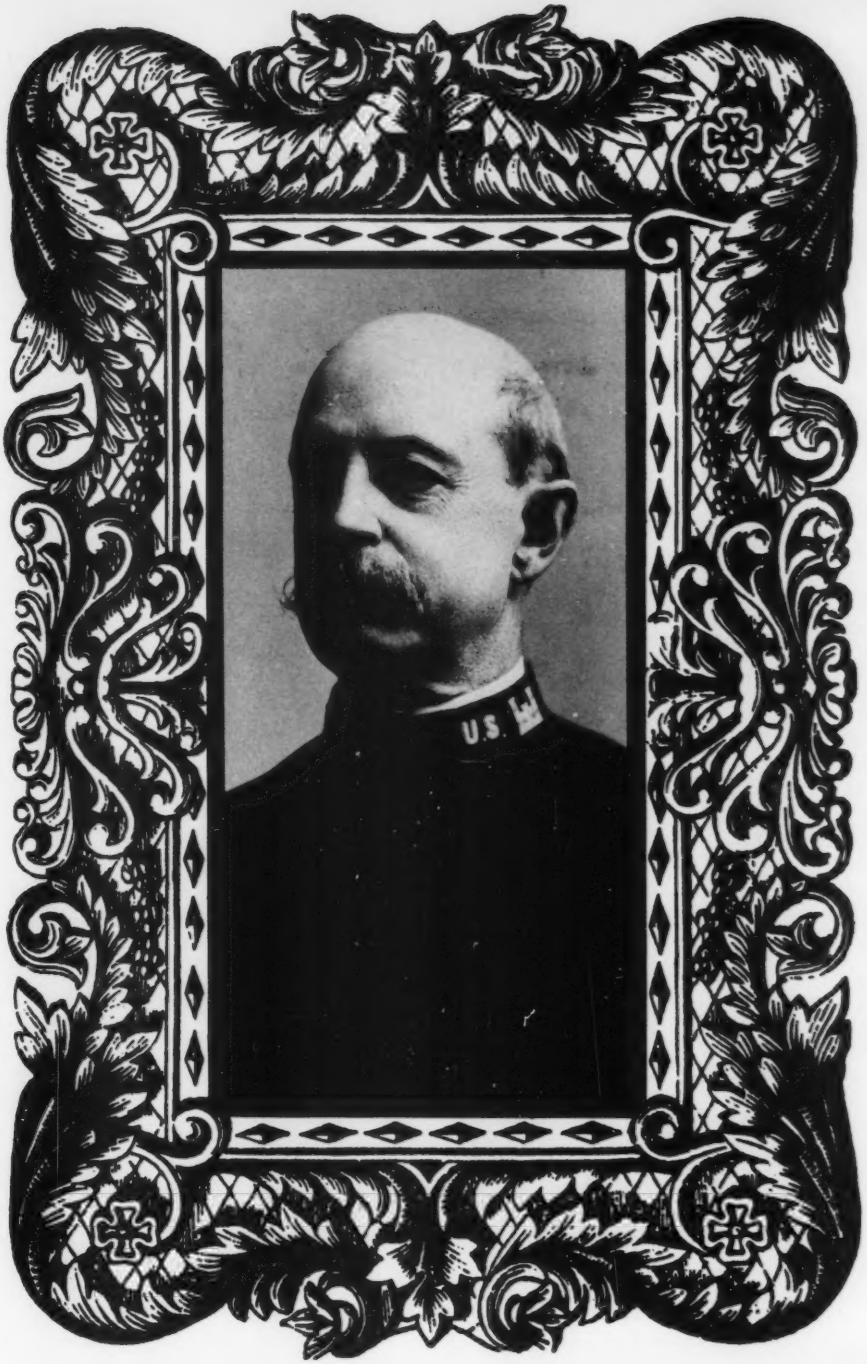


Captain Raymond explores the Yukon

by Lyman L. Woodman
Public Affairs Officer
Alaska District

At the time of Alaska's purchase from Russia, the U.S. Army Engineer Corps was almost 100 years old and well established as the young Nation's pool of engineering expertise. It was logical, therefore, for a military officer to have been chosen to determine what was then a pressing issue: who owned the ground on which the Fort Yukon trading post stood—established by the English-owned Hudson's Bay Company.

Thus, the first American military exploration of Alaska's interior occurred as the result of an 1869 expedition up the Yukon led by a young U.S. Army Engineer Corps officer named Captain Charles Walker Raymond. The historical motivation for this journey, into what was then an unmapped wilderness, can be traced back to two events that preceded the Raymond expedition by many years.

An Anglo-Russian treaty consummated in 1825 established a boundary on land the Russians had never seen. This treaty established the eastern boundary of what was then Russian America at longitude 141 degrees west. This was at a time when the Russian-American Company administered this territory for its mother country. The Russians, who had been colonizing this territory since 1784, concentrated their efforts on obtaining furs, which were more than amply supplied within the huge territory's southeastern and south-central sectors. There was no need to venture into the vast interior.

The Russian fur company did recognize, however, the commercial potential of the giant river that flowed into the Bering Sea from hundreds of miles inland, and opened a trading station at Saint Michael, near one of its numerous mouths, in 1833. Four years later an independent Russian trader set up a trading post at an old Indian settlement called Nulato, which was 600 miles farther up this waterway, for which the Russians had adopted the Eskimo name Kvichpak (or Kwikpak). It was the fur company's easternmost station in that part of Russian America.

Meanwhile, hundreds of miles farther east, representatives of the Hudson's Bay Company opened two posts on the Yukon River. Thus, in 1847 the second significant event occurred when a factor for the Hudson's Bay Company, following orders from his company, developed a post in the vicinity of the joining of the Yukon and Porcupine Rivers. The factor, Alexander Hunter Murray, knew at the time that his fort was in Russian territory, but it was not known until 16 years later that his post and the Russian station at Nulato far to the west were on the same river.

Part of this confusion came from the fact that Murray approached this junction with the Yukon by coming down the Porcupine River from the direction of British North America. The Yukon, however, starts many miles farther inland at the northern edge of what later became the Province of British Columbia. It runs northwesterly through what is now Yukon Territory and crosses the 141st longitude long before the Porcupine joins it well inside Alaska (then Russian America).

Murray built his fort strongly, more out of fear of the Russians than the Indians. The river, however, was long enough to serve both trading companies without any violent confrontation. In fact, the resulting competition was beneficial to the Indians. The year after Russian-America's sale to the United States, though, the Hudson's Bay Company's right to trade at Fort Yukon was fiercely contested by newcomer American traders.

Secretary of State William H. Seward, who had negotiated the purchase from Russia, at first observed that the existing law prohibiting foreigners from trading with American Indians was technically sufficient to prevent the encroachment of Hudson's Bay Company into Alaska. It soon became evident, though, that if English trade was to be stopped, it had better be nipped at the roots by taking possession of Fort Yukon. As the fort's position had never been determined scientifically, however, it would be necessary to send a surveying expedition up the Yukon to establish its exact longitude.

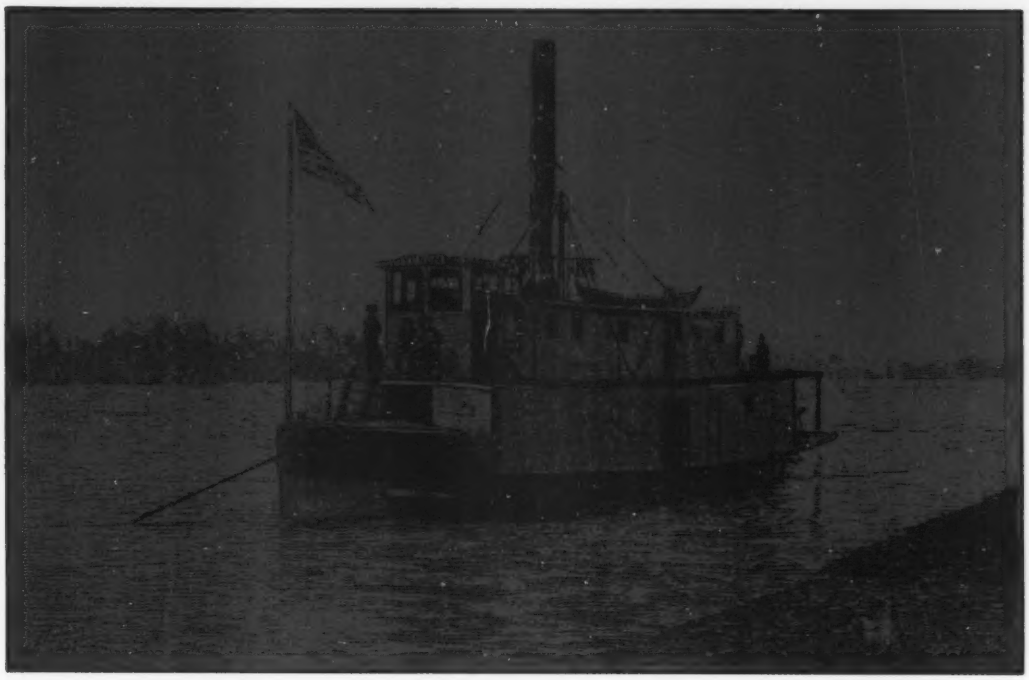
The person selected for this mission was Captain Raymond, a Civil War veteran only 4 years out of West Point when he joined the Military Division of the Pacific headquarters in April 1869 at San Francisco. It was from here that he was detached to investigate Fort Yukon. Captain Raymond and his assistant, John J. Major, sailed aboard the brig *Commodore* on April 6, 1869 bound for Sitka, Alaska. Its final destination was a new trading station to be established on Saint Michael Island, site of the former Russian Michaelovsky Redoubt. Hudson Stuck, author of "Voyages on the Yukon and Its Tributaries," observed that the *Commodore* "belonged to some San Francisco traders who were

A STEAMER FOR ALASKA

Capt. R. H. Waterman has had constructed a small stern-wheel steamer, to be called the *Youkon,* to run on a river of that name and others in northern Alaska, for trading purposes. Her dimensions are: Length, 50 feet 7 inches; beam, 12 feet; depth, 3 feet 6 inches. Her engines are two in number, 9 inches diameter of cylinder and 30 inches stroke. The paddle wheel is 9 feet diameter and 6½ feet wide. When loaded she will draw 18 inches of water, and she will run at a speed of 10 miles per hour with 60 pounds of steam, and 12 miles with 100 pounds. She was built by Wm. H. Gates. She will be transported to her destination on the deck of a vessel, by taking out her boiler, engines and wheel and hoisting her on deck.—*Bulletin.*

We believe in the full success of this expedition. Kwichpak river is rich in resources of all kinds, in mineral and also fur bearing animals. Silver Foxes from that place have brought the price of forty dollars for each skin.

Wood-burning Youkon *plied Yukon River as commercial vessel until 1881 ice breakup crushed it.*

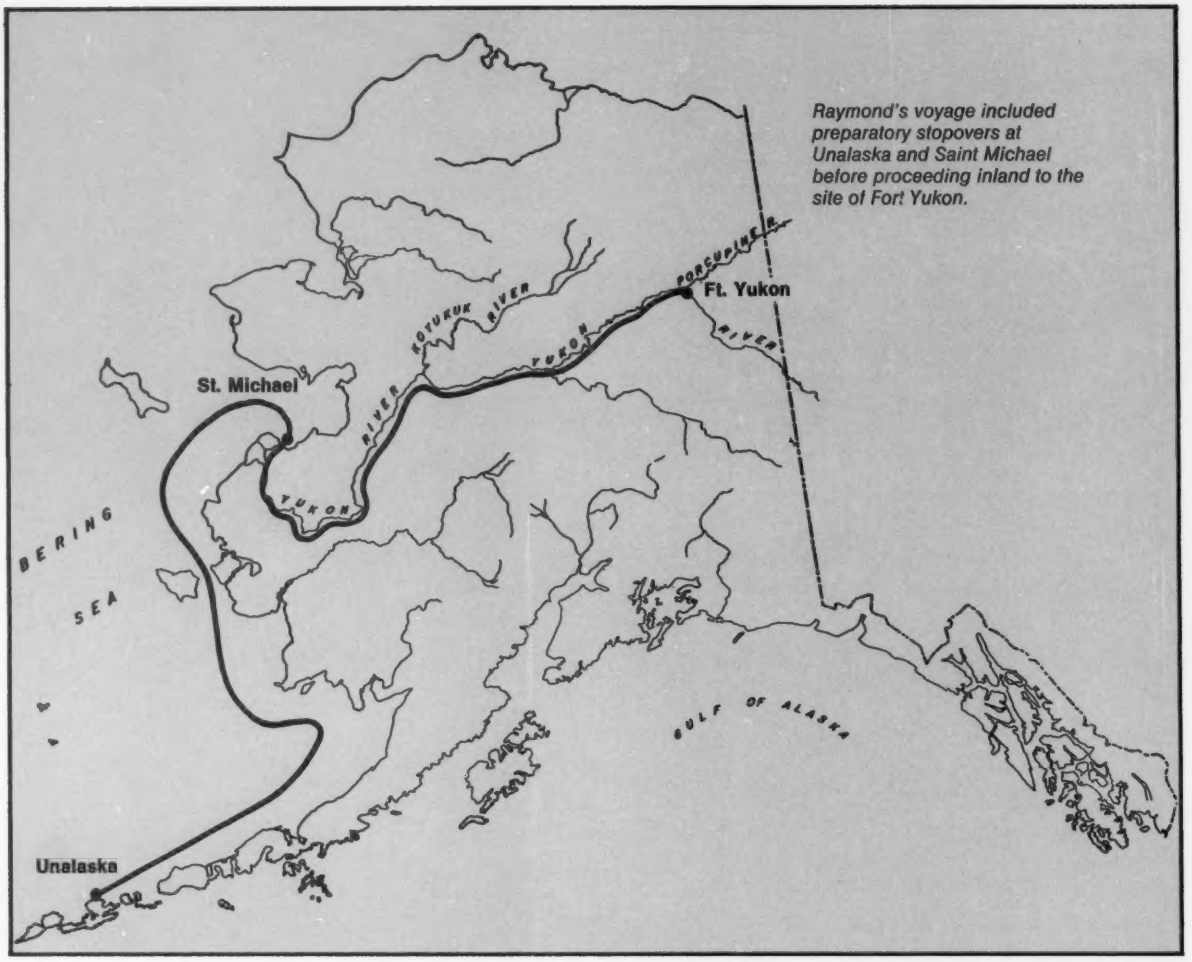


patriotically resolved to supplant the Hudson's Bay Company should they (sic) prove to be intruders."

The "patriotic" souls, representing Parrott & Company, had on board the brig a small stern-wheel steamer which they planned to use going up the Yukon. The river's several wide and shallow mouths could accommodate only vessels of very shallow draft and the little steamer, which heretofore plied the waters of San Francisco Bay, was a scanty 50 feet long and 12 feet wide. It was said that "her homely outline suggested a cow barn on a scow." She was named the *Yukon.*

On arriving at the former Russian capital of Sitka, Captain Raymond was joined by Private Michael Foley, 9th Infantry, assigned to the expedition by the Military District of Alaska's commander. The following year, in a speech before the American Geographical Society in New York, Captain Raymond was to refer to Private Foley as his "bodyguard."

The *Commodore* left Sitka on May 9. After a stormy 12-day voyage across the North Pacific it arrived at Unalaska in the Aleutians, then headed for Saint Michael after a 2-week delay. The last leg was expected to take a week, but extensive ice fields and a severe gale caused the voyage to last 24 days. The *Commodore,* therefore, did not arrive until June 29. The military expedition party remained at Saint Michael for 4 days making preparations for the river journey. On July 1 the little stern wheeler was launched and given a trial run. A small, rough pilot house was constructed on the deck by the *Yukon's* merchant owners, who also procured two large open boats to carry supplies and trading goods.



"On the evening of the third," Raymond later reported, "our preparations were all complete. At midnight, in honor of Independence Day, we discharged an old Russian cannon obtained somewhere on the route, taking care to keep at a safe distance and use a very long string. Early on the morning of the Fourth of July, taking our boats in tow, with flags flying and guns firing, we started on our voyage to the upper mouth of the great river."

Captain Benjamin Hall was the *Yukon's* master, aided by an Eskimo engaged as a navigator at Saint Michael. "They groped their way," Raymond reported in his journal, "among countless islands and shoals, occasionally grounding or turning back to seek a more favorable channel. The waters of the Yukon discharge into the Bering Sea through a labyrinth of blind, misleading channels, sloughs, and swamps extending for more than 100 miles upstream where they unite into the main channel. The country is scarcely above the level of tides, and covered with a monotonous cloak of scrubby willows and rank sedges. It is a vast inland sea filled with thousands of swale islets scarcely peeping above its surface. The whirl of its current is strongly marked by a rippling rush and the drift-logs that it carries on its muddy bosom."

Raymond's journal continues: "As there was a bright twilight during the short time that the sun was below the horizon, we traveled night and day, only stopping occasionally to obtain wood or to purchase a few skins or a little game at some native village. Our approach was usually the occasion of considerable excitement. As we drew near a village we were accustomed to herald our coming by a vigorous sounding of the whistle, and this was usually followed by a general stampede of men, women, children, and dogs. Our little steamer, which, puffing about the bay of San Francisco had seemed a mere toy, appeared to them a huge monster, breathing fire and smoke."

Raymond's own words best describe the remainder of the voyage aboard the brig. "Throughout the trip," he wrote in his journal, "I alternated with Mr. Major in taking notes and bearings from which to construct a map of the river, and we employed every opportunity to make observations on shore. We found this duty somewhat severe, as it had to be continued throughout both day and night, and our accommodations were so limited that it was often impossible to obtain a place in which to sleep when not at work. The swarms of mos-

Aerial view near mouth of river confirms Raymond's description of lower Yukon as a vast inland sea filled with swale islets.
Bureau of Land Management

quitos and gnats which abound on the river during the months of June and July proved a very serious annoyance. When the boat was not in motion we were obliged to wear face nets and gloves, and on one occasion an attempt to make sextant observations failed completely from this cause."

The steamer stopped often for wood, usually cut from drift timber found piled in large heaps at short intervals along the river. Since the vessel could only carry four cords at a time, it had to stop after about every 10 hours of steaming. The voyagers stopped for 2 days at Anvic (now Anvik), a small native village at the mouth of the Anvic River where the merchants accompanying Raymond's expedition established a trading station. This was a memorable part of the river for Raymond, who wrote: "About 20 miles above Anvic the river narrows and the current runs with great velocity. Doubts had been expressed as to the possibility of our passing this point. By skillful management, however, this obstacle was overcome without serious difficulty. At the request of the entire party, I gave this place the name 'Hall's Rapids' in honor of Captain Hall, first master to pass this point with a steamer.

"We arrived at Nulato on July 19th. This was once the easternmost station of the Russian-American Company, but at the time of our visit it had been abandoned." Another trading station was established here by the merchant voyagers and a few observations were obtained by Raymond.

The next crucial point in the journey came about 17 miles above Fort Adams,[1] where Raymond reported: ". . . we passed the mouth of the Tanana River, the waters of which increase the current of the Yukon for a considerable distance. From this point the river gradually narrows and its banks increase in height. We were approaching the Rampart Mountains, and the rapids of whose dangers we had heard so much from the natives below. About noon on the 25th we arrived at the entrance of these rapids, and, after taking on a good supply of wood, we passed through them without great difficulty, although the channel is narrow and the current runs with great rapidity."[2]

The expedition was now entering the lower limits of a broad, watery, troublesome expanse called the Yukon

[1] An American log house trading station located in the vicinity of the present village of Tanana.

[2] The trans-Alaska petroleum pipeline now being constructed will cross the Yukon in this area on the first bridge ever to be built over this river.

Yukon River winds through Rampart Canyon near its junction with the Porcupine.

Flats. The noted explorer-scientist Alfred Hulse Brooks defines the flats as "a great lowland, swampy area bounded by a rim of highlands with a length of some 200 miles and a width of 40 to 100 miles . . . (the river here) is made up of an intricate network of shallow channels. . . ."

Finally, "on the 31st of July, at 4 p.m.," Captain Raymond's account continues, "we arrived at Fort Yukon, thus successfully terminating the first journey by steam ever made on the Yukon River. The time of actual travel, including stoppages for wood, was 23 days, and the distance passed over about 1,040 statute miles. At Fort Yukon, notwithstanding the somewhat unpleasant character of our errand, we were cordially welcomed by Mr. John Wilson, the agent of the Hudson's Bay Company."

With the river rapidly falling, Captain Raymond was anxious to make an approximate determination of Fort Yukon's geographical position without delay, in order that his companions might carry back the information to the coast. A week of unfavorable weather prevented suitable observations until the 7th of August, wrote Captain Raymond, when "we obtained a good observation of the solar eclipse, from which we were able to compute an approximate longitude, sufficiently accurate to set at rest the question at issue, and inform our traders that they were in American territory."

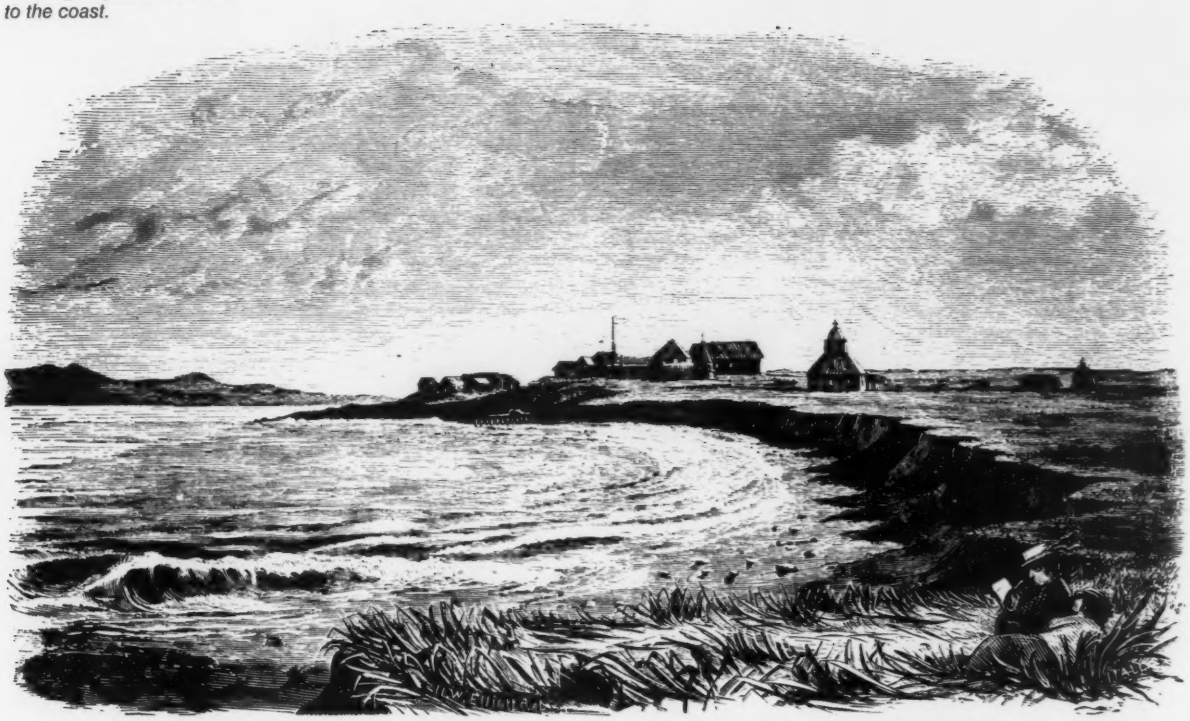
Captain Raymond then added: "It seems proper to say, in this connection, that by General Halleck's[3] permission I had consented temporarily to represent the Treasury Department, and under the instructions of that Department, on the 9th of August, at 12 m., I notified the representative of the Hudson's Bay Company that the station was in the territory of the United States; that the introduction of trading goods, or any trade by foreigners with the natives, was illegal, and must cease; and that the Hudson's Bay Company must vacate the buildings as soon as practicable. I then took possession of the buildings and raised the flag of the United States over the fort."[4]

Early on the morning of August 10 the steamer started on her return trip down the river, leaving Ferdinand Westdahl and Moses Mercier in charge of the American trading station which had been established at the fort. "I also remained," Captain Raymond's journal continues, "with Mr. Major and Private Foley, in order to obtain observations for more accurate determina-

[3] Maj. Gen. H. W. Halleck, commander of the Military Division of the Pacific.

[4] The captain's letter to Agent Wilson was signed "C. W. Raymond, Inspector of Customs, U.S. Treasury Department."

Saint Michael's Redoubt as it looked when brig Commodore *used its harbor as an anchorage awaiting Raymond's return to the coast.*



tions. The nights were so light as to greatly embarrass astronomical observations, and I desired, therefore, to remain as long as possible."

Finally, late in August, when the river's level had become low—indicating the freezing of upstream tributaries—Captain Raymond, Mr. Major, Private Foley and two natives started down the Yukon in a skiff "of well-seasoned timber sawn from spruce drift logs. She was caulked with rags and finally coated thickly with pitch. It was called the *Eclipse*."

The party took a small tent, and for provisions a ham, a small piece of bacon, a little hardtack, and about 25 pounds of moose pemmican, "a very seasonable present from Agent Wilson."[5] They also had an ample supply of tea, "the universal drink . . . in this country." In decent weather they were at the oars from sunrise until it became too dark to proceed with safety. The skiff was difficult to keep tight, and many repair stops had to be made. They picked up a few more provisions at Fort Adams, and 4½ days later arrived at Nulato.

No replacement boat could be obtained here, and the Indians would not accompany the group any farther. The expedition members went on under adverse conditions, including a near wreck in Hall's Rapids. Thereafter it was one man bailing and two at the oars. An attempt to get a large native sealskin boat (badarra) and native aid at Anvic to go down the Yukon also was unsuccessful. However, John Clark, in charge of the Anvic station, volunteered to help the travelers on an alternate route up the Anvic River and across a portage to the Eskimo village of Ikikiktoik, 17 miles east of Saint Michael. Clark obtained six birchbark canoes and some Indians to help on the trip, which started September 14.

It was slow going up the Anvic by poling. To add to the party's hardship, it was soon discovered that most of the provisions supposedly packed safely in one of the canoes had been left behind. A man was sent back to the station with a note requesting that supplies for 5 days be sent to them. The note was misread and the messenger returned with enough for a single meal which the group ate on the spot, all of them agreeing to live upon the country thereafter.

On September 18 Captain Raymond and his companions came to a village where they "made a hearty meal on fish seasoned with gunpowder" and learned that, on account of the river's shallowness, it would be impossible to reach the portage entrance by water. De-

[5] Wilson had notified his superior earlier that month that "Captain Raymond is a very nice fellow."

Fort Yukon as it appeared when Hudson's Bay Company operated trading post there. Hudson's Bay Company

termined to press on, they exchanged the canoes for a large badarra which drew less water, but by dark found that further progess could not be made by boat.

Captain Raymond summarized the situation with an entry that reads: "We were now about 50 miles from the river's mouth, and probably about 20 miles from the portage, and we had to choose between two courses. We could easily return to Anvic and winter at that place, or we could attempt to cross the country in a direct line to Ikikiktoik on the coast. The first course seemed out of the question, since the station at Anvic was provisioned for only three men. On the other hand, a portage across an unexplored country of an extremely difficult character, known to be intersected with mountain ranges, necessitated a dependence principally upon the rivers for our supply of food. As this might be cut off in a moment by a sudden change of weather, it appeared equally impracticable.

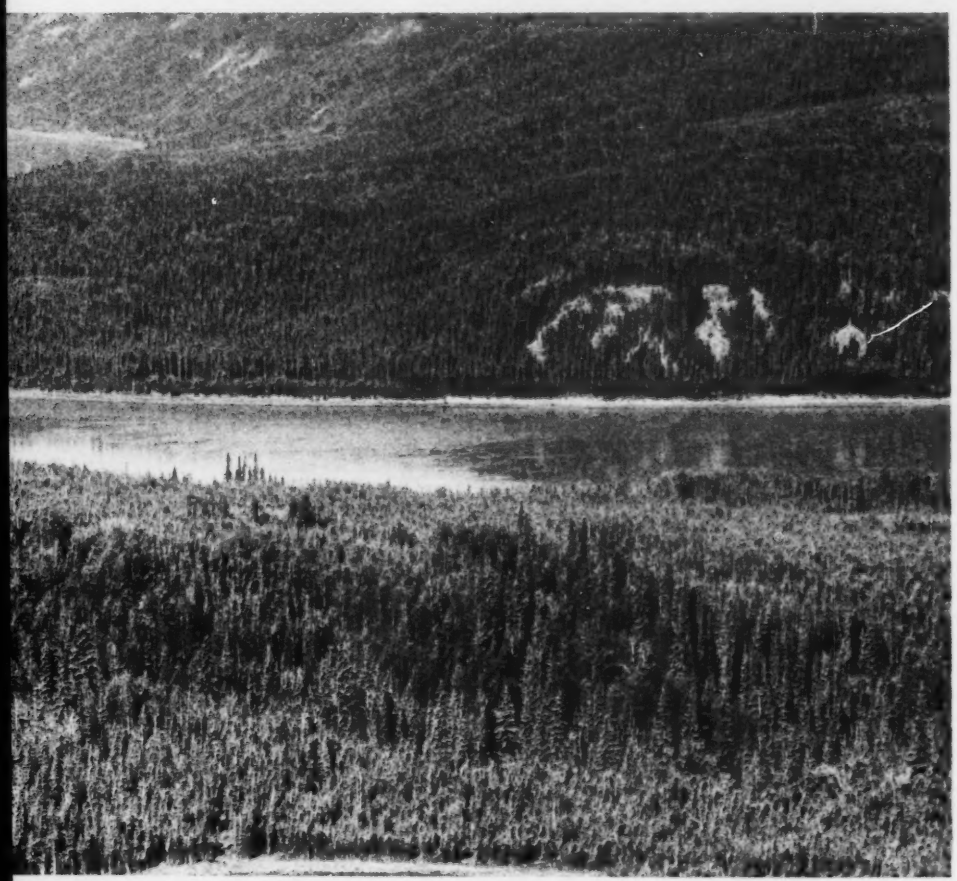
"After much anxious discussion, it was finally determined to keep on, and not to turn back unless it should become absolutely necessary. During the night there was a violent rainstorm. In the morning we packed everything which was necessary to carry on the backs of the Indians. We abandoned our tent and such other articles as were not absolutely required and began our journey."

They trudged on for several days, up and down hills and divides, through dense brush that scratched at their arms and legs, and swampy ground covered with hummocks before they reached Ikikiktoik thoroughly exhausted. Unfortunately, the village was virtually deserted and there was only a small one-person boat available, so they had to stay the night. A messenger dispatched next day brought a food-laden whaleboat and a ride over to the *Commodore's* anchorage at Saint Michael.

"Thus," wrote the tired explorer, "ended our eventful and, in many respects, unpleasant journey." Captain Raymond's party arrived in San Francisco on November 6, some 7 months after their departure, with a valuable map and more information about the Yukon and Alaska's interior than any military expedition had ever before developed. In later years, General William T. Sherman, then commanding the entire Army, remarked in a letter to Henry Ward Beecher:

"I think I know and appreciate Captain Raymond fully. . . . He made bold and successful exploration of the Great Yukon River in northern Alaska, and his report thereof I regarded as a model of elegant scholarship."

As a result of Captain Raymond's visit, the Hudson's Bay Company built a new post on the Porcupine River, naming it Rampart House. So difficult was determination of position in the wilderness without astronomical instruments, that the company felt another move was necessary in order to be certain its station was on Eng-



Yukon River view near site of bridge to be built by pipeline construction company.
Alyeska Pipeline Service Co.

A modern look at trading post site shows same oxbows and watery flats encountered by Raymond expedition. Today's Ft. Yukon is a modest city of 700 population. Nearby runway marks home base of Alaskan Air Command squadron.

lish soil. Thus, post number three was destroyed and buildings called New Rampart House were erected 12 miles farther upstream.

When precise surveys were made in 1903, a year before Raymond retired as a brigadier general, the United States-Canadian Boundary Commission found that New Rampart House was no more than a couple of hundred yards within Canada. Meanwhile, the original Fort Yukon had been torn down to supply wood for Yukon River steamers, according to a Canadian geologist-explorer; and the sturdy little stern-wheel puffer, the *Yukon*, was crushed in the ice breakup of 1881, succumbing to the onslaught of the huge ice chunks that moved downstream that spring.

Thus, nothing now remains that can be associated with Captain Raymond's expedition except his notes, maps and journal entries that have been preserved. His mission, however, is well remembered by historians and a grateful Alaska. ■

Recent articles in Water Spectrum about wildlife management on Corps projects have been presented from the perspective of resource managers. We felt it was now time to include the viewpoint of a participant and invited Glenn Titus, an avid outdoorsman and photo journalist, to visit the project of his choice for hunting or fishing—and write it like he saw it (including the title). This is his story.

OUTDOOR CORPS

By W. Glenn Titus

A small flock of a dozen or so mallards swung over the decoys, Conrad sounded off with the feeding chuckle, and on the next approach they set their wings into the strong northwest wind. As they side-slipped down, their long necks craned forward and their orange, webbed landing gear came down. Just three hens in the bunch, they settled in among the bobbing decoys not 15 yards from our camouflaged boat pulled up into the tall cattails. "Beautiful," I whispered to Conrad, but neither of us reached for our shotguns.

Buck, Conrad's chocolate-colored Labrador retriever, was about to come uncorked. He had seen this flock against the low black clouds and came to full alert before we did. Shivering with anticipation, Buck looked at his master, at the ducks in the decoys and then at me, as if to ask, "What are you guys waiting for?" Shooting ducks was what we came here for, but Conrad already had a greenhead (35 points) and a gadwall hen (15 points) in the boat, and I had a mallard drake. With the limit of 90 points and one duck figured under the point system, he could take two more mallard drakes, as could I, plus a gadwall, if taken in the right order.

However, we didn't want the day's shooting to end before sunrise. With 300,000 mallards cranking around the Sequoyah National Waterfowl Refuge we wanted to squeeze in every drop of enjoyment possible by sampling the variety of duck hunting here. It would be no trouble to fill our limits, it was just a matter of when.

Sequoyah Refuge, named for the Cherokee Indian who developed an alphabet for the Cherokee language, is located southwest of Sallisaw in eastern Oklahoma and includes the upstream half of the Robert S. Kerr Lock and Dam project that covers 20,800 acres.

The U.S. Army Corps of Engineers bought the refuge land to help mitigate the loss of wildlife habitat which resulted from construction of the Arkansas River navigation project. This land is now licensed to the U.S. Fish and Wildlife Service, which manages the refuge. Adjoining lands dedicated to wildlife are either licensed to the Oklahoma Department of Wildlife Conservation, or managed by the Corps itself.

Sequoyah is a relatively new refuge, established in December of 1970, and benefits from a feature unique to Oklahoma refuges. The water level is stable because of navigational use. This gives rise to abundant aquatic vegetation such as emergents, like the cattails where we hid our boat, and submerged plants, such as the pond weeds which are so attractive to waterfowl and other water birds.

Sequoyah is also a refuge in the modern sense of the word, with well over half the space within the boundary designated as a public hunting and fishing area, and all of the refuge is open to the general public for hiking, bird watching and nature photography.

We were hunting one of the many cattail islands on the eastern part of the refuge. However, a variety of waterfowling is available here: field hunting, pond jumping, pass shooting, jumping ducks off the river and even over decoys in the flooded timber Stuttgart style—and hunting in the flooded timber is where Conrad and I planned to fill out our limit.

As outdoor editor for the major daily newspaper in Oklahoma, I keep in close touch with the waterfowl situations in the south-central United States in general, and in Oklahoma in particular. It was just before the second part of Oklahoma's split waterfowl season opened that refuge manager Bob Stratton called me with a report of a record number of mallards using the Sequoyah area—230,000 of them. He said one of the refuge employees, while attempting to census the ducks, walked out on a dike along one of the flooded soybean fields and the place was alive with ducks. He clapped his hands and the world turned to mallards. "We've got 'em this year," Bob said.

In order to get some good pictures, I arrived at the refuge headquarters in Sallisaw on Thursday evening before Saturday's opening. "Three hundred thousand mallards is the latest total," a grinning Bob Stratton said, even before saying, "Hello." The next day we were to fly over the refuge but a front out of the north moved in with clouds, wind and rain, so we toured the refuge in a four-wheel drive unit, barely managing to escape the clutching mud on several occasions.

"Welfare of the wildlife, particularly waterfowl, and providing quality outdoor experiences for those who visit the refuge are the primary objectives on the Sequoyah area," Bob said as we turned south from Interstate 40, south of Vian. Two more miles and we crossed the boundary at the familiar sign of the flying goose and stopped at the self-service information box, where free maps and regulations are available.

The author is outdoor editor of the Daily Oklahoman & Times *(Oklahoma City, Okla.), a regional columnist for* Outdoor Life, *and a director of the Outdoor Writers Association of America.*

Left—Even with 300,000 mallards cranking around the area it takes a good spread of decoys to bring this wary bird into shotgun range.

Center—As a pair of greenheads made a pass over the decoys, Conrad came up shooting from the bass boat hidden in the cattails.

Bottom—The payoff on all those hours of training is that exciting time when your dog shows that he knows his business.

It seldom fails! You have given up on this spot, your shotgun is on shore, and you are out picking up the decoys; that's when the ducks come in and land right in the blocks.

We took the self-guided tour road across Sally Jones Lake, which really is an old cutoff oxbow of the Arkansas River. There were ducks everywhere! This tour around the lake offers excellent opportunities to see and enjoy the wildlife here for tourists as well as bird watchers, photographers and waterfowl hunters. Although waterfowl receive most of the attention, it is not at the expense of other wildlife; management practices benefit a variety of resident game and nongame species as well.

"Elbow to elbow people *don't* make for a quality outdoor experience—photography, hiking or hunting—so if we manage the refuge so as to spread out the wildlife, we can spread out the people. We may reach a point in the future where there will be too many people on the area and some regulations may then be necessary, but we don't anticipate that anytime soon," Bob said.

As Sally Jones Lake is shallow, hunters with only a half dozen decoys, a pair of waders and perhaps a call, can find some excellent waterfowling. On the Sandtown Bottom area, south of Sally Jones Lake, there are 10 ponds where hunters with no more equipment than a shotgun can get in on some good pass shooting as the ducks trade back and forth between ponds. Besides the ponds in the bottom, feed crops such as soybeans, exotic varieties of peas, milo, corn and wheat are planted, not only to feed the waterfowl, but to spread them out. "We have between four and five thousand acres under cultivation with share croppers who leave about one-third of the crop for wildlife. These people are mostly former landowners or tenants." Income from their share of the crop contributes considerably to the local economy. This, added to the refuge payroll plus what the hunters bring in, is more than the same land would produce in straight agriculture, Stratton said.

"The harvest is handled in a couple of different ways: we have the farmers leave our share in unharvested strips and then intersperse with an aerial seeding of wheat (to provide green pasture for the geese), or we may take the refuge's share of the crop and plant it along the margin of a slough which will be flooded in the fall, and then the banquet table is spread," Bob explained.

On the way to the western part of the refuge that follows along the Canadian River and Dirty Creek, we drove back to I-40, crossed the Arkansas on a high bridge where Bob pointed out several large privately owned fields that were barren of cover. "That's what Sandtown Bottom was like prior to the refuge. There were no field borders, no edge strips. It was plowed from fence to fence. In the wintertime it was almost like a desert—no cover whatever, for any kind of wildlife," he said.

It was raining harder as we pulled into Area A. Several long, wide sloughs meandered across a large soybean field. Bob honked the horn and the field erupted—3,000 ducks, give or take a couple, lifted up, moved farther away, but then went right back to eating. Where a slough drained through a tinhorn under the roadbed, a water control structure (like farmers use to irrigate land) was holding the water back, flooding the partially harvested soybean field. "This is part of the hunting area on the refuge," Bob said. I could hardly believe those ducks would be there when the season opened the next day! It appeared that a dozen decoys set along any one of a half dozen sloughs would have ducks all over a hunter. I could hardly wait to show this to my hunting buddy.

With all that rain, the refuge roads were bad but "they

"Fetch!" is the only command Buck needs to spring from shore in his classic belly flopper dive as he heads for a downed duck.

Bob Stratton inspects the yield from an exotic variety of peas planted just for wildlife food.

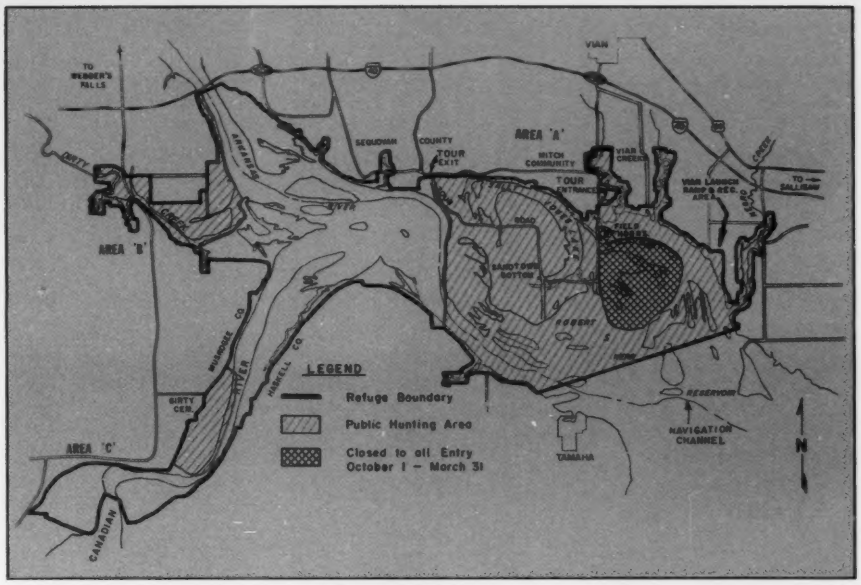
Even the harvested areas, abundant with waste soybeans, provide a banquet for waterfowl.

Bob honked the horn and the partly flooded soybean field erupted into the rain darkened sky—3,000 ducks and a small contingent of geese lifted up, moved farther away, but then went right back to eating.

would be a whole lot worse if it hadn't been for the Corps' project engineer loaning us some heavy equipment," said Bob. "We get good cooperation from the Corps here."

I found that Sequoyah, like other refuges, is not over funded; $72,000 is the current annual budget. With salaries for four employees, there isn't much left over for programs. This is one reason public camping is not permitted on the refuge; there isn't enough money to have someone maintain the campgrounds and pick up the trash. Also, the Corps has several good camping areas close by.

Back on to the paved road and a half-mile south we crossed a bridge over Dirty Creek. It is navigable in a small boat for several miles upstream and offers a good opportunity to jump shoot waterfowl, Bob said. There is no launch ramp here, but a small boat can be carried down the bank. We continued on 4 miles south and



There are three separate public hunting areas on the Sequoyah Refuge. Area "A" is the largest, starting with the cattail covered islands just south of Vian boat ramp and around the mouths of Big and Little Vian Creeks. To the west is the closed area and Sandtown Bottom. Here Sally Jones Lake, numerous potholes, and flooded grain and bean fields offer a variety of waterfowling. Area "B"—along Dirty Creek—is good for field hunting or jump shooting ducks off the creek. The Canadian River—Area "C"—offers field shooting as well as hunting flooded timber. Best access is the Girty Cemetery road. A note of caution: firearms may not be transported by boat between the areas; one must use the roads.

1 mile west to Girty Cemetery, and then down into the bottomland along the Canadian River. On both sides of the road ducks were flying off the partly flooded soybean fields. All the mallards in the central flyway must be here, I thought. Bob showed me where he'd go if he didn't have to work opening day—a spot where the timber comes to the edge of a flooded bean field.

Besides all of the hunting areas within the refuge boundary, the U. S. Army Corps of Engineers has also given license to the State Wildlife Department to manage another 2,000 acres, including several islands, for a public shooting area on Kerr Reservoir, just downstream from Sequoyah. The problem with hunting there is not in finding a place to hunt, but deciding where you want to start.

That night I camped at the Corps' Sallisaw Creek Public Use Area and had it all to myself until Conrad Vollertsen, my hunting buddy who teaches English at Sand Springs High School, arrived. He brought his Labrador retriever and an 18-foot bass boat, complete with padded swivel seats. When I questioned his good sense, he hauled out a burlap cover with a splotchy dye job for camouflage. As plush a duck boat as I ever hunted from.

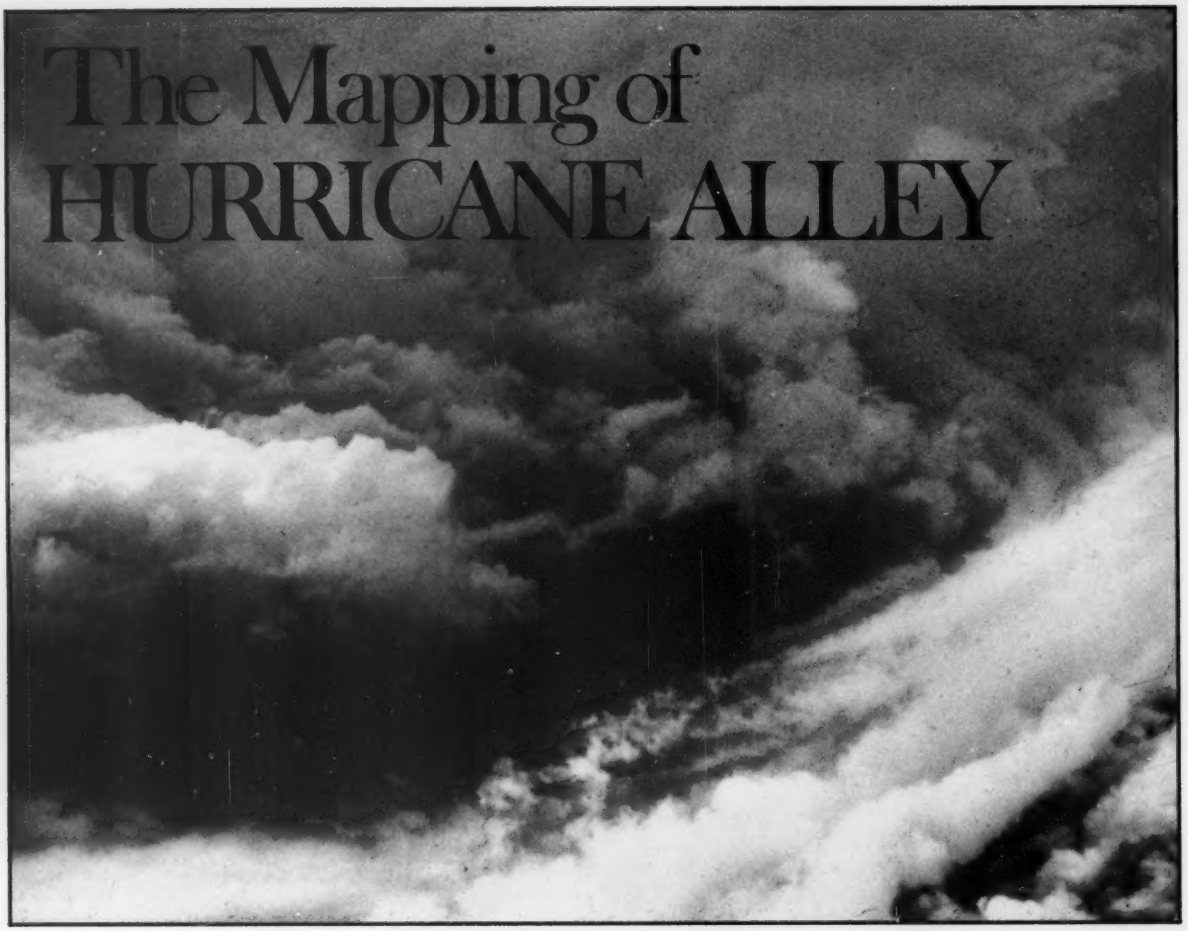
We launched from the Vian ramp the next morning, and after putting out about 30 decoys, ran the boat up into the cattails, bent a few over the cover and the mallards came in like we weren't even there. There were about 25 other boats out among the cattail islands, but they were scattered far enough apart as not to cause problems. As I mentioned earlier, we had three ducks in the boat and had quit shooting to save some of our limit for later in the day.

After we picked up our blocks we motored over to where a couple of other hunters were picking up. John Johnson of Sallisaw, and his son Mike, held up three fat greenheads apiece. "This is my kind of hunting," said Mike and then razzed his dad for missing a shot at a duck that was hovering over the decoys. They could hardly believe two guys would quit shooting just so they could hunt later. "Take 'em when you can!" was Mike's advice.

After a long, leisurely lunch at a Vian restaurant, Conrad, Buck and I drove to the Girty Cemetery and walked down through the soybean fields. It was strangely different from yesterday, the rain had stopped, the sun felt good on our tired muscles. The ducks were gone also, but they would be winging it back in for supper.

No other hunters were in the area as we sloshed through the flooded timber and came to Bob's choice spot where the water flooded into the unharvested soybeans. "Better get those decoys out," I encouraged Conrad, but doubt was stalking both of us. The wind had stilled and it was a beautiful afternoon; however, without wind to make them move, the decoys would look like just what they are—decoys. A pair of wood ducks made a pass over and, in spite of Conrad's calling, flew into the timber behind us. Later, as the sun colored the horizon, we watched mallards by the thousands, flying high over the Canadian River, going out somewhere to feed. There we were in the middle of 300,000 mallards with only a pair of greenheads and a gadwall to show for our day's effort. Perhaps Mike Johnson's admonition, "Take 'em when you can!" was right; but then I wouldn't have traded that afternoon for two more ducks to clean. ■

The Mapping of HURRICANE ALLEY



- *Over 12,000 dead!*
- *Damage estimated as high as $30 billion!*
- *Hundreds of thousands homeless!*
- *Thousands of homes and businesses destroyed!*

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by Raymond Wilcove
Public Affairs Officer
National Ocean Survey, National Oceanic and Atmospheric Administration

Add up the costs above and you have the toll for this century alone from one of man's deadliest enemies, the giant whirlwinds spawned by nature that we call hurricanes. They may buffet any area of the Atlantic and Gulf Coasts with the fury of their winds and waves, creating havoc for shoreline communities, and then drench vast areas with torrential, flooding rains as they move inland.

While the national hurricane warning system has improved steadily since the loss of 6000 lives in 1900—when the island city of Galveston was inundated by storm-driven water from the Gulf of Mexico—the options remain the same. Once a hurricane warning goes out, residents in the endangered areas can only do one of three things. The initial reaction is "batten down the hatches," stay put and hope to ride out the storm. However, when Camille struck in 1969, a wind-driven wall of water two stories high swept into Gulfport, Miss. and swept out again with that community's people, homes and almost everything else in the water's path.

The second option is to head for the closest school, armory, auditorium or other large structure designated by local authorities as a storm shelter. The problem with exercising this option is that there may not be enough shelters to house all of the storm-threatened populations.

Thus, the third option may be the wisest of all: evacu-

Year	Hurricane	Areas	Highest Wind (mph)	Deaths	Damage
1965	Betsy	Southern Florida & Louisiana	136	75	Much due to flooding, particularly in Louisiana
1967	Beulah	Southern Texas	109	15	Major floods in Southern Texas, killing 10. Record number of tornadoes spawned (155)—killing 5.
1969	Camille	Mississippi, Louisiana, Alabama, Virginia & West Virginia	150-175	255 dead 68 missing	Storm tide to 24.2 feet above sea level in Mississippi. Flash floods in Virginia.
1970	Celia	Texas	161	13	Costliest ever to strike Texas.
1972	Agnes	Florida to New York	56 storm tide 6.4 feet above normal Apalachicola, Fla.	122	$3.56 billion for U.S.; $2.1 billion w/50 deaths in Pennsylvania alone. Spawned 15 tornadoes in Florida and 2 in Georgia. Devastating floods from North Carolina to New York with many record breaking river crests.

ation inland into those areas better protected against the ravages of the approaching storm by natural terrestrial features. Few people in the coastal zones, however, realize they might be in any danger from hurricanes. According to Dr. Neil Frank, director of the National Hurricane Center in Coral Gables, Fla., the reason for this is that an estimated 21 of the 35 million people inhabiting these zones have had no experience with hurricanes. During the period from 1961 to 1970, when Carla, Hilda, Betsy, Beulah, Camille and Celia successively battered the Gulf Coast, there was not even *one* severe hurricane along the entire East Coast.

Project a storm similar to Camille onto one of the East Coast's more populous centers during the June to November hurricane season of 1969 and you have a faint idea of what the toll might have been. As it actually occurred that year, Camille pummelled the less densely populated 5-State area of Mississippi, Louisiana, Alabama, Virginia and West Virginia with winds gusting between 150 to 175 miles an hour and storm surges measured as high as 24.2 feet above sea level in Mississippi. Left in the hurricane's wake were 323 dead and missing and damage estimated at $5 billion. In Virginia alone, Camille dropped more than 2 feet of rain in 8 hours, causing flash flooding that resulted in 150 dead and missing.

Hurricanes not only induce flooding, but tornadoes as well. Beulah spawned a record 150 in 1967 and peak winds up to 200 miles an hour were reached on some of the central Florida Keys in a 1935 storm.

It has been two decades since the likes of Carol, Edna, Hazel and Diane swept up the Atlantic Coast between North Carolina and New England causing 360 deaths and damages estimated as high as $6 billion. Since then, the population has increased tremendously. As a result, there are millions of new residents who have never experienced the awful effects of a full-blown hurricane.

Hurricane Betsy can provide a good example. When Betsy struck southern Florida and Louisiana in 1965, she caused 75 deaths and considerable damage. The most severe part of Betsy missed the heavily populated Miami area. Today, in Dade County, which includes metropolitan Miami, a million and a half people (75 percent of the population) have never experienced even a moderately strong hurricane such as Betsy.

Broward County, just north of Miami, has one of the most rapidly growing populations in the country, yet nearly 90 percent of the county's 800,000 residents "just don't know what a strong hurricane is all about," according to NOAA's Dr. Frank. The last moderately strong storm to make a direct hit on Broward County was in 1947, when the population was *less than 100,000*. Today, it is increasing by almost that much each year.

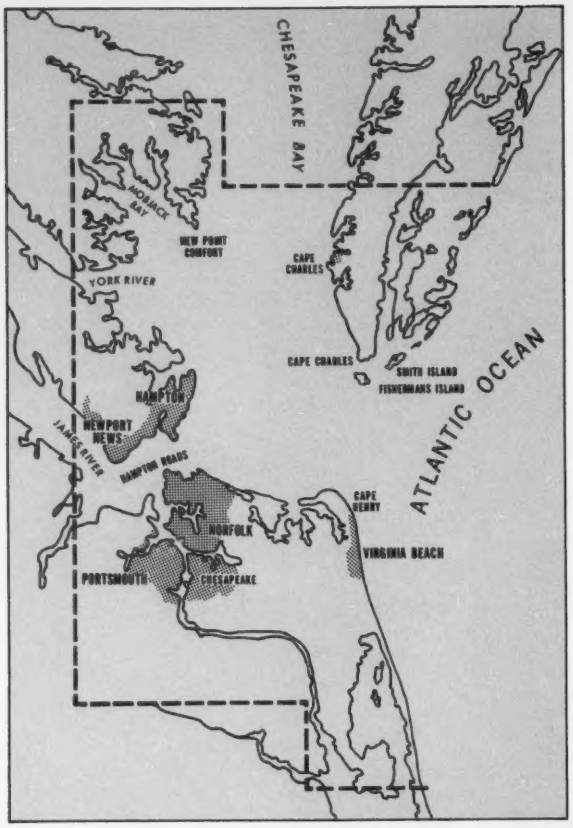
The buildup of coastal populations has forced Federal agencies to begin concentrating on the third option mentioned earlier, evacuating people from the endangered areas. A prerequisite was the determination and publicizing of safe evacuation routes. The result: the storm evacuation maps.

In an effort to assist civilian authorities direct their coastal populations to safety, the National Oceanic and Atmospheric Administration (NOAA) of the U.S. De-

Aftermath of Hurricane Camille included unexpected house call by this fishing trawler at Biloxi, Miss.

Below—Palm-tree lined Florida waterfront bears brunt of storm's fury as this hurricane approaches its landfall.

Royal palm pierced by 10-foot pine board was freakish effect left by winds gusting over 200 miles an hour. Annual average of 6 tropical storms are spawned in North Atlantic during June to November hurricane season.



Several maps, each covering approximately 24 by 30 statute miles, are published for a given geographical region, such as the heavily populated Greater Tidewater area of Virginia.

This stretch of Gulf Coast road would be a questionable evacuation route for future storm, depending on its force and direction.

Bent prop screw on stern indicates this freighter was under power in vain attempt to avoid being driven ashore by abnormal surge of high water accompanying hurricane force winds at Gulfport, Miss.

partment of Commerce is planning to publish approximately 185 storm evacuation maps over a period of about 15 years. These maps are being distributed to authorities faced with the responsibility of planning the evacuation of refugees from any point located in "hurricane alley," which is virtually the entire coastal zone bordering the Atlantic Ocean and Gulf of Mexico.

Few residents of these coastal zones are aware that these maps are also available to the public, since only 1440 have been purchased by individuals out of the approximately 11,000 placed on public sale. NOAA's National Ocean Survey prepares and publishes the maps, which are distributed by the National Weather Service to those Federal, State and local authorities responsible for evacuating residents from storm-threatened coastal communities. About 400 copies of each new map are distributed immediately and another 200 placed on public sale. On the average, about 40 of each new map are bought by the public.

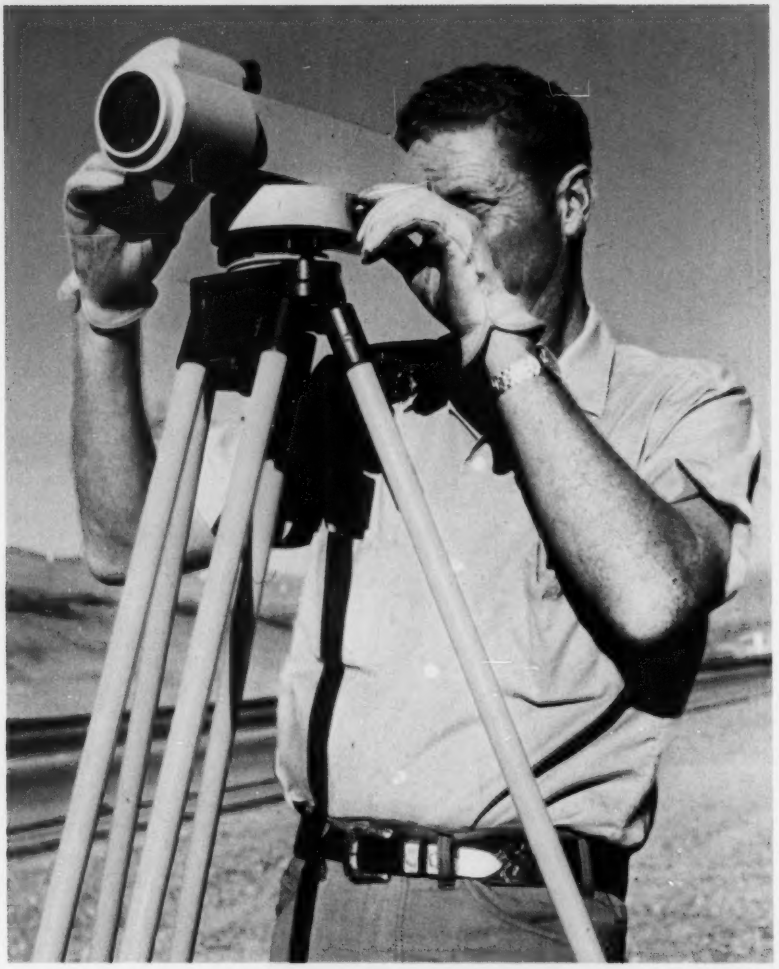
One of the reasons the public has not become more aware of these storm evacuation maps is the fact that the program remained in a state of incubation for over 20 years until the first of the present series of 42 maps developed to date was issued in 1971. The intent of the

Evacuation maps are a valuable tool for coping with any major storm, including the 1962 northeaster that smashed these homes on Fire Island, N.Y.

new program is to furnish map coverage for the entire Atlantic and Gulf Coasts, a task that may not be completed until 1987 according to National Ocean Survey estimates.

The present series of maps grew out of a 1965 request by the old Weather Bureau which approached the National Ocean Survey's predecessor, the Coast and Geodetic Survey, on the possibility of preparing modern storm evacuation maps. It was not until 1970, however, that a series of meetings between the National Weather Service and Survey personnel produced an agreement to draw up a prototype map of the Mobile, Ala., area—which is considered a high risk region.

Preparation of this prototype proved complex, but interesting. The planners tried red, orange, blue, green and purple to denote the various elevations. Red was finally decided upon, with the deepest tones denoting the lowest ground and progressively lighter tints indicating the higher elevations. Before deciding on red, the map makers tested their colors on closed circuit television to determine how each map color would reproduce in both color and black and white. Today's red tinted maps will



Preparation of flood maps requires field survey to measure elevations along possible evacuation routes.

reproduce well on television, and can be used during a hurricane warning to provide a large audience of viewers quick visual information on the safest evacuation routes. However, there has been no report as yet of any maps being televised for this purpose.

During the preparation of the Mobile prototype map, the National Weather Service held lengthly discussions with the Red Cross, civil defense and officials that would be involved in evacuations. One of the problems was how best to identify an evacuation route. Initially, only route numbers were to be carried on the map for each road. Then it was decided to add the names of the roads as well. Meteorologists subsequently asked that the roads be further described as being surfaced or unsurfaced and show the number of lanes available in each direction. Railroads and airports were added, then State and county lines and, finally, population figures were provided for each major urban area, small town, village and resort.

With inputs from numerous sources, the current series of maps has evolved into a set of documents with a surprising amount of information. Typically, each map includes the main evacuation and feeder routes, with ground elevations spaced at 2-mile intervals and special elevation readings at high and low points along each road. All of these details are printed sufficiently clear to be reproducible in newspapers.

The actual putting together of each map has been a painstaking and time consuming task that starts with a preliminary map drafted by the Coastal Mapping Division personnel at the National Ocean Survey headquarters in Rockville, Md. This is an unrefined, but complete hand drawn compilation based on topographic maps, aerial photographs and other data obtained by the National Ocean Survey from the U.S. Geological Survey, the Department of Agriculture, the U.S. Army Corps of Engineers and, in some cases, from county and city agencies. This hand drawn map carries all the basic details that eventually appear on the final product.

A field man checks the accuracy of the information and makes certain the elevations appear at least every 2 miles along the evacuation routes in the potential flood zones. The National Weather Service supplies information on the historical high water marks of past storms and meteorologists discuss with the field man the principal evacuation routes under storm conditions.

The average evacuation map covers an area about 24 by 30 miles, requiring an average of 2 to 4 weeks of field surveying, depending on poulation density. In an

Left—Cartographer compiles storm evacuation map by enhancing contours from base map on overlay.

Red Cross officials, such as this representative assisting victim of Hurricane Isabel, are among those sent copies of each map.

area this large, the major concern is to accurately map the potential flood zone, which extends from the water line to somewhere between the 20- and 30-foot elevations. Dependent on the area's topography, an average of 100 or more elevation points are surveyed on each map. The field data are submitted to the National Ocean Survey where the finished product is printed in a size roughly equal to a double-page newspaper spread.

As each map is distributed, the civil disaster authorities in yet another costal area receive a valuable new tool in their efforts to reduce the toll from future hurricanes. Since man cannot predict nature's whims, only careful preparation will produce positive results. The real value of these maps will not be known until they have been tested in some future contest against one of nature's giant water-laden whirlwinds slamming into a heavily populated coastal region. ■

The topic of land use management is so important to the associated water resources affected that Water Spectrum is continuing its land use series with the following article. The Florida Environmental Land and Water Management Act of 1972 appears to be a working land use law being applied within a State containing many unique land areas.

Land Management in the Sunshine State

by Andrew A. Dzurik, Ph.D.

Florida's Environmental Land and Water Management Act of 1972 is being observed closely by many other States because of its potentially significant impact on State approaches to managing both man-made developments and natural resources. The 1972 Act contains provisions regarding two items of extreme importance to State planners. These are *areas of critical State concern* and *developments of regional impact*.

Florida, in particular, must pay attention to these two items, since it currently lays claim to the dubious honor of being the fastest growing State in the Nation. The State's current population of almost 8 million is more than double the 1950 population, and it will likely top 14 million by the end of the century. This rapid growth and its associated impacts are key factors which led to enactment of the new legislation.

Florida, along with the rest of the Nation, climbed on the environmental bandwagon in the late 1960s and early 1970s. However, while President Nixon's stopping construction on the Cross-Florida Barge Canal crystallized public interest in the environment and the Miami jetport controversy heightened that interest, it took a real State crisis to generate enough public support for major change.

A severe drought in south Florida in 1970 and 1971 was part of a cyclical phenomenon of drought and heavy rain in central and south Florida. This particular one was especially severe, compounded by the increased population and manmade changes to the landscape. The vast and intricate system of canals, dikes, dams, and other water control devices was simply inadequate and, in many ways, detrimental to the water situation. (Not only are vast amounts of rainfall carried away from aquifer recharge areas by this system, but also hundreds of thousands of acres of natural wetlands have been converted to urban development.)

The unprecedented dry spell endangered much of south Florida, including the coastal urban areas, and the vast reaches of the Everglades and Big Cypress Swamp. Falling water tables and the related salt water intrusion led to water rationing. Raging fires in the Everglades and Big Cypress not only destroyed huge stands of cypress and pine, but also consumed rich organic soils and created serious smoke problems for the coastal cities.

In response to these conditions, the Central and Southern Florida Flood Control District requested the Governor's office to organize a conference to deal with the water shortage problem. This proposal was expanded by the Governor's staff to include the broader issue of water management in south Florida. Governor Reubin Askew called together some 150 experts in science, agriculture, conservation, and government in September 1971. What began as a water management conference was broadened to cover interrelated environmental, land use, and development issues. The consensus of the conference included the following: water management is a statewide issue; any solutions to water management problems must be related to land use and development; and Florida should move toward an effective State land use program.

Dr. Dzurik was the resident scholar at the Board of Engineers for Rivers and Harbors, Ft. Belvoir, Va., during the 1974-75 academic year. He has since returned to his post as associate professor, Department of Urban and Regional Planning, Florida State University, Tallahassee, Fla.

Provisions of Florida's 1972 land use law are enabling planners to set aside areas of critical State concern from the effects of rapid urbanization.

Raging fires in the Everglades destroyed shrinking stands of cypress and pine, and created smoke problems for coastal cities.

Although conference findings such as this are often laid to rest, Governor Askew followed up this conference within a few weeks by appointing a Task Force on Land Use Planning. Its primary charge was to draw up new legislation to implement recommendations of the conference, and to recommend legislation to bring about long-term solutions to land and water use problems in the State. The task force studied several approaches to land and water management. The most notable State approach at that time—Hawaii's system of statewide zoning and permitting—was rejected as being inappropriate for a State as large and diverse as Florida. Instead, the task force opted for a bill patterned after the American Law Institute's model land development code.

By February 1972, the task force had prepared a legislative package with the aforementioned land management bill as the key component. The following April, the Florida Legislature passed, by a large margin, the Florida Environmental Land and Water Management Act of 1972. The legislative intent of the act was to encourage the State to establish land and water management policies to guide and coordinate local decisions on growth and development that local governments could implement without having to violate private property rights. The act distinguishes four major elements:

- areas of critical concern
- developments of regional impact
- administrative appeals procedures
- establishment of the Environmental Land Management Study Committee

Areas of Critical State Concern

As specified in the 1972 Act, an area of critical State concern may be designated only for:

"An area containing, or having a significant impact upon, environmental, historical, natural, or archeological resources of regional or statewide importance.

"An area significantly affected by, or having a significant effect upon, an existing or proposed major public facility or other area of major public investment.

"A proposed area of major development potential, which may include a proposed site of a new community, designated in a state land development plan."

In actual practice, substantial documentation is needed to support any recommendations for critical areas. A further limiting factor is that the total amount of land which may be designated as critical areas shall not exceed 5 percent of Florida's land. This requires prioritizing eligible areas according to their relative scale of importance. The 5 percent restriction could prevent a comprehensive treatment of all the critical resources in the State.

The basic process for designating critical areas requires the Division of State Planning to recommend specific areas for adoption to the Administration Commission, which consists of the Governor and the Florida Cabinet. Boundaries of the proposed area must be specified, reasons why the area is of critical concern to the

State or region must be stated, dangers from uncontrolled development and advantages of controlled development must be given, and specific principles for guiding the development of the area must be recommended. Although the Division of State Planning may receive suggestions from local, regional and State agencies for potential critical areas, the division is responsible for initiating and conducting the critical area studies.

Within the first 6 months after adoption of an area of critical State concern by the commission, the local government having jurisdiction of that area may submit its existing land development regulations or any new regulations to the Division of State Planning. If the division finds the local regulations are in compliance with its principles for guiding development in that area, it approves the regulations and they immediately become effective.

If local regulations are nonexistent or insufficient, the Division of State Planning will prepare development regulations, subject to the approval of the commission. Although local governments administer any land development regulations adopted under this section, the Division of State Planning can monitor area activities to ensure that land development provisions are being fulfilled and, if needed, institute appropriate judicial procedures to compel proper enforcement of the regulations.

Three Areas Designated

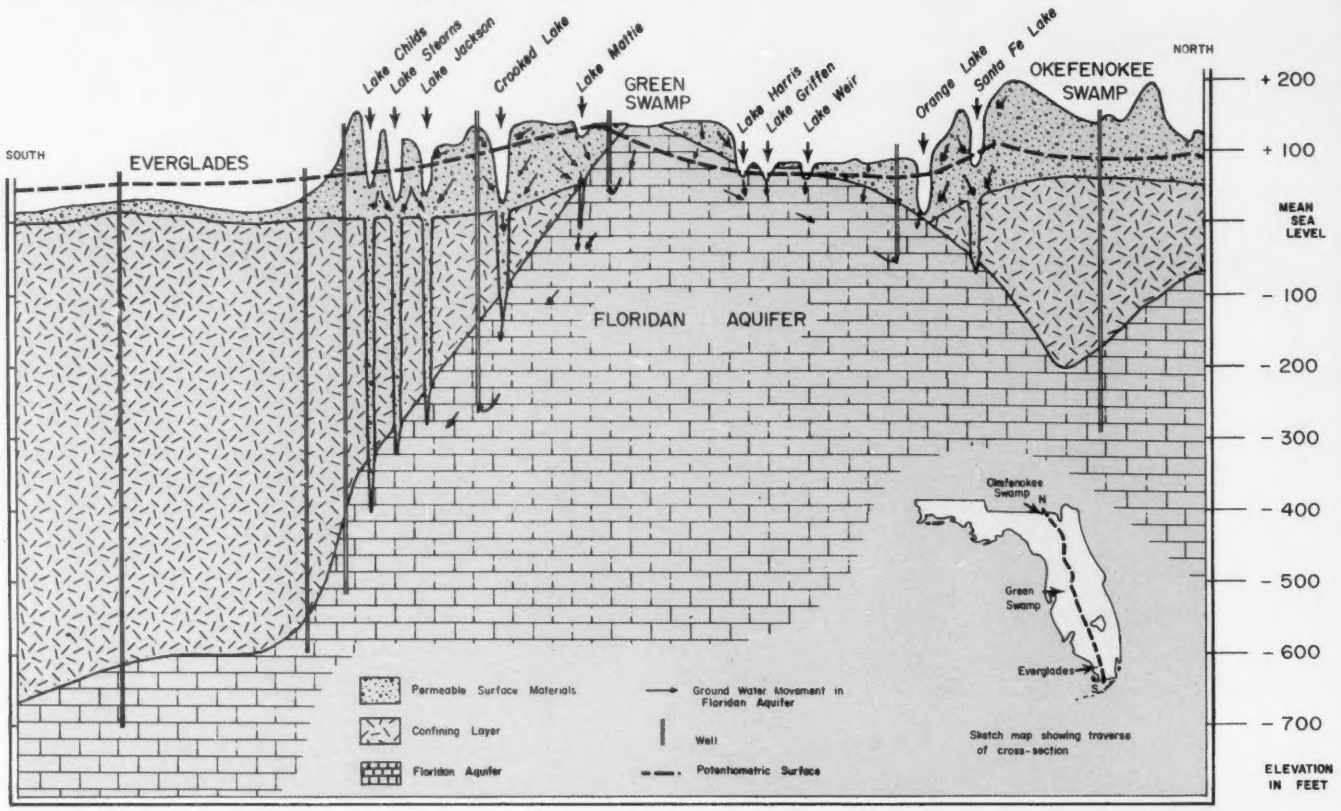
To date, three critical areas have been designated by the Administration Commission. Thirty-three other potential areas are currently listed for State investigation. When sites are reviewed for their importance to regional and State concerns, but do not meet the required criteria, then the Division of State Planning may assist and guide the area jurisdictions in developing regulations to safeguard local resources. The three designated critical areas are the Big Cypress Swamp, the Green Swamp, and the Florida Keys.

Big Cypress. The Big Cypress Conservation Act of 1973 designated the Big Cypress Swamp as the State's first critical area and charged the Division of State Planning with responsibility for drawing the specific boundaries. Specifically, the boundaries had to include the water resources of the Big Cypress, the Everglades National Park, and the fresh-water aquifers and estuarine fisheries, such as the Ten Thousand Islands, of south Florida. The Florida Legislature also appropriated $40 million of its Federal funds for acquisition of the new Big Cypress National Freshwater Preserve proposed in the eastern half of the Big Cypress.

In August 1973 the division proposed 1.2 million acres within and surrounding the Big Cypress National Freshwater Preserve, an area encompassing 75 percent of the entire watershed. The public hearings and political maneuvering that followed persuaded the Administrative Commission to reduce the area outside the preserve to 285,000 acres, most of which are unsuitable for development.

Lands used for agriculture and forestry are excluded from the Big Cypress Conservation Act, except

Central Florida's Green Swamp, encircled by expanding urban areas, lies directly above the massive Floridan Aquifer that serves as a ground water resource for the entire State.



when plans to develop these lands are to be initiated. This provision confines the critical area to the coastal wetlands, salt water marshes, freshwater sloughs, and parts of the mangrove islands.

Green Swamp. In June 1974, the division recommended portions of the Green Swamp basin, located in the Central Highlands of the Florida peninsula, as an area of critical State concern. The commission agreed that central Florida's rapidly urbanizing areas of Orlando, Tampa and Lakeland-Winter Haven surrounding the swamp were affecting the region and the State's water resources. As a result, some 322,690 acres in the eastern part of the swamp were declared a critical area.

The Floridan Aquifer underlying the Green Swamp supplies 90 percent of the region's and 70 percent of the State's ground water for use in public water systems, irrigation and industry. The highest elevation of this ground water level in the entire State occurs within the boundaries of this critical area. Thus, the extreme amount of head pressure found in this area maintains many free-flowing springs, allows easier withdrawal of water through wells in central and southern Florida, and prevents salt water intrusion.

The critical area also provides 55 billion gallons a year, or 70 percent, of the Green Swamp basin's total recharge of the underlying aquifer necessary to replace water withdrawn or discharged. Since the recharge function of the aquifer depends upon permeable surface soils and wetlands, uncontrolled surface development can sizably reduce their effectiveness. The dense wetlands that comprise 50 percent of the critical area not only help recharge the aquifer by retaining seasonal rains for extended periods, but also assist flood retention facilities and storm water channels in reducing damage from heavy runoffs.

Florida Keys. The most recent area proposed is the focus of a pilot program for the State's coastal management plan and was originally recommended by the Florida Coastal Coordinating Council. Encompassing 70,000 acres, the Florida Keys constitute a reservoir of natural, manmade and historical resources of both regional and statewide significance. On April 16, 1975, the Florida Keys also were designated an area of critical State concern.

The natural resources on this chain of islands of highest importance to the State are the coral reefs, mangroves and tidal shoreline areas, which serve to maintain shoreline stabilization, high water quality and productive wildlife habitat. Preserving these resources sustains tourism and commercial fishing, two main contributors to the economic vitality of the Keys that depend on the area's water quality.

Current public service problems are insufficient

Preserving mangroves and tidal shoreline areas sustains tourism and commercial fishing in the Florida Keys.

water supply, inadequate solid and liquid waste treatment facilities and limited fire and hazard protection. Uncontrolled development could create insurmountable problems for each of these systems and influence future Federal investments in the Overseas Highway, Key West Naval Station and water pipeline facilities.

Developments of Regional Impact

Developments of regional impact (DRI) are in distinct contrast with critical areas. Whereas critical areas focus on preserving natural or historical areas, developments of regional impact concentrate on proposed major developments and their impacts. Twelve categories of "Developments Presumed to be of Regional Impact" are spelled out in the Florida Administrative Code:

- airports
- attractions and recreation facilities
- electrical generating facilities and transmission lines
- hospitals
- industrial plants and industrial parks
- mining operations
- office parks
- petroleum storage facilities
- port facilities
- residential developments
- schools
- shopping centers

Threshold levels have been established for each category describing the size that activates the DRI process—for example, industrial parks or plants on sites larger than 1 square mile or with more than 1,500 parking spaces. If a proposed development is above the threshold level, the developer must go through the DRI review process, which primarily involves local governments and regional planning agencies, and is incorporated into the usual regulatory processes.

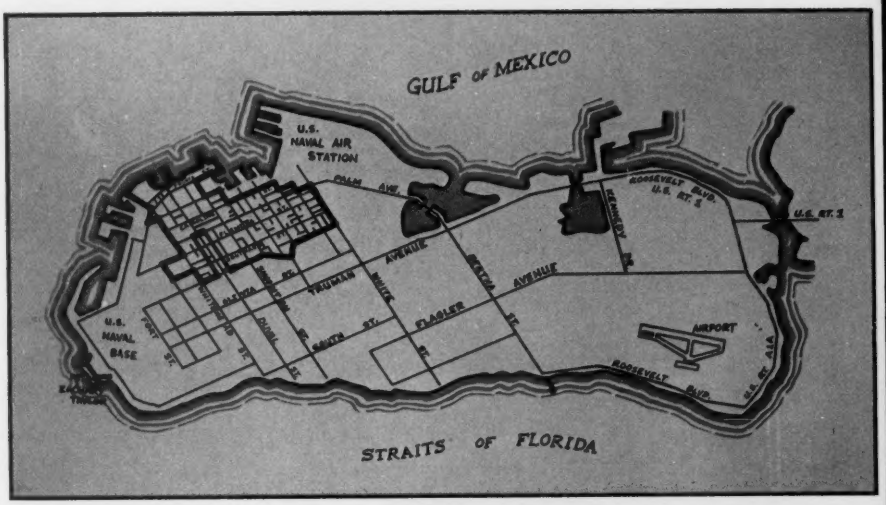
The 1972 Act establishes three broad objectives in dealing with DRI:

- assist local governments in making decisions on developments with greater than local impact,
- provide an opportunity for all persons affected by a proposed DRI to be heard at a public meeting, and
- establish an appeals procedure.

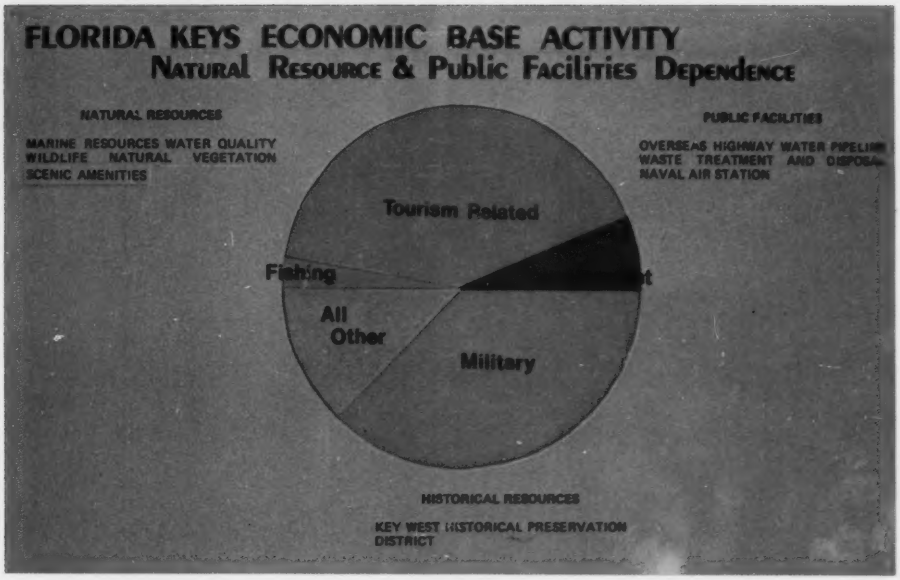
The 1972 Act defines a DRI as one which, "because of its character, magnitude, or location, would have a substantial effect upon the health, safety, or welfare of citizens of more than one county." The four primary participants in the development process are the developer, local government, regional planning agency, and Division of State Planning.

The developer initiates the review process by filing an application with the appropriate local government and regional planning agency. Included with the application is a report regarding the proposed development's impacts on the region's environment and natural resources, economy, public and transportation facilities, and housing supply. The local government must respond by giving at least 4 weeks notice of a public hearing, by which time the regional agency must have prepared its own impact report and be ready to make recommendations to the local government.

It is the local government's responsibility to decide whether to approve the proposed development, deny it, or approve it subject to certain conditions, restrictions or limitations. This decision, under the 1972 Act, must take into account three things: the State land development plan, local land development regulations, and the regional planning agency's report and recommendations. In other words, the review process provides the



Florida Keys area of critical State concern includes this historic preservation district represented by architectural features below.



Key West Naval Station is a development of regional impact that helps support total economy of Florida Keys.

local government additional inputs to its decision-making process in those instances where greater than local interest are involved.

Other Major Elements

The third major provision was the creation of a Florida Land and Water Adjudicatory Commission, which also consists of the Governor and cabinet, to act as the appeals body for matters concerning critical areas or DRI. Where a decision—a permit issued or denied—is rendered by the local government, the owner or developer, regional planning agency, or State planning agency may appeal to the commission within 30 days. The commission then has 120 days in which to issue or deny a development permit pursuant to the act, and it may attach conditions or restrictions to its decision. If satisfaction is still not obtained by all parties, the decisions of the commission can be brought up for judicial review.

The final major provision of the act was the creation of the 15-member Environmental Land Management Study Committee. Representation included environmental interests, organized labor, business interests, the home construction industry, the academic community, the land sales industry, the real estate profession, and agricultural interests. The committee was terminated by the act itself on June 20, 1974, but was extremely active and influential in its brief 2-year history. After numerous meetings and conferences, the committee prepared recommendations for new legislation and amendments to existing legislation that were deemed necessary to achieve the goals established for environmental management in Florida.

Problems and Prospects

The 5 percent limitation on selection of critical areas may be relatively insignificant in a State with such vast tracts of environmentally sensitive lands. Protection of a major recharge area, for example, requires control over far more territory than the areas approved to date. Although the critical area provisions of the 1972 Act hold significant potential for exercising State control, the full power and application of these provisions have yet to be tested.

Initial difficulties with the DRI process stem from the perennial problem of appropriations. The demands of the 1972 Act call for a much higher level of funding if the act is to achieve its potential in protecting critical areas and controlling developments of regional importance.

The limited range of experience with the DRI process indicates that impact models are needed at the local and regional levels. Regional agencies still rely on relatively crude methods for determining the impacts of large scale developments and use a reactive rather than a positive approach to locating certain types of developments. Emerging approaches to development and land use controls have the potential for influencing future patterns of growth and environmental quality in Florida. That State's experiences, in turn, should provide other States the opportunity to learn better approaches to their own growth problems and attempts at improving the quality of life for their citizens. ■

A multiregional approach toward land resources planning along the Tennessee-Tombigbee Waterway results in:

A Compact for the Future

by Bruce J. Hanson

Since 1958, five States, Alabama, Kentucky, Florida, Mississippi and Tennessee, have been working together to build the Tennessee-Tombigbee Waterway. The States, members of an interstate compact, have bound themselves together under this agreement in the Tennessee-Tombigbee Waterway Development Authority, a planning and development compact unique in the United States.

Through the efforts of these States, embodied in the Authority, local and national public support and congressional approval was obtained for the waterway project. Funding, authorized by the Congress, enabled construction of the project to begin in December of 1972.

With initiation of construction, however, an additional, new role was cast for the Authority. The Governors of the compact States became aware of the tremendous impact a public works project of this magnitude would have on the region and that the States were not prepared to plan for the orderly development of the landsides of the waterway to prevent a piecemeal approach by individual States and local authorities. This was considered crucial since these States are, in ever increasing fashion, competing in national and world markets and without plans and coordinated investments, maximum State benefits would not be possible.

The new role of the Authority, formalized in July 1973, became one of planning coordinator, as designated by the Governors of the compact States. With the assignment of that added task came the necessity of developing a mechanism whereby intrastate and interstate policy, planning and management of investments, and comprehensive land use planning could be focused on the corridor of the waterway; specifically between south-central Tennessee through northeast Mississippi and west Alabama to the Gulf of Mexico. The intent of the Governors was clear in that they wanted the Authority, since it could virtually span boundaries between States, to be a rallying point for planning or, better still, the catalyst to quantify diverse viewpoints.

While construction of the project itself is confined to Mississippi and Alabama, the impact on the economies of those States is immediate because of wages paid or materials purchased. On the other hand, Kentucky, Tennessee and Florida have water or waterway accessibility now which will present a different kind of impact on their economy after the Tennessee-Tombigbee Waterway is opened. Their problem becomes intensified since, with new markets available for their products, facilities and plans will have to be developed to capitalize on the new access provided by the waterway. Even more important, the ancillary elements such as highway access, schools, housing, public utilities, etc., will have to be included in those plans.

The author is deputy director of planning and research for the Tennessee-Tombigbee Waterway Development Authority at Columbus, Miss.

Opposite—This industrial site on the Tennessee River will benefit from a more direct route to the Gulf via the Tennessee-Tombigbee Waterway.

Charged with this new responsibility, the Authority began to seek financial assistance from the Federal Government which resulted in several small planning grants under section '701' from the Department of Housing and Urban Development (HUD). Among the first tasks undertaken by the Authority was an assessment of what had been done to plan for the impact by all units of government affected by the waterway. In addition, interviews were conducted at line level departments in State government to assess their awareness of the project and to determine if they were prepared to undertake any planning efforts for the waterway.

Two important indicators resulted from the assessment and interviews: one, that there had been little local or regional planning related to the waterway accomplished and that what had been done was piecemeal and two, that line departments at the State level were almost entirely unaware of project impact, leaving them virtually unprepared to develop landside plans for the waterway. Even more importantly, nothing was being done to prepare plans on a coordinated basis.

It was within this frame of reference that the Authority established a Planning Coordination Committee within the five compact States. The structure of the Committee relies on the Authority as the legal body with which State, regional, and local units of government will deal. Membership on the Committee is as follows: Alabama—State planning director, plus two executive directors of regional planning agencies which lie along the waterway; Mississippi—the coordinator of Federal-State Programs and two other members, a director of a regional planning district adjacent to the waterway and the director of a local water management district; Tennessee—the State planning director, plus one regional planning agency member; Kentucky—State planning director; and Florida—the State planning director. Also members of the Committee are the two Corps district engineers responsible for construction of the project, the Authority Administrator and Tennessee Valley Authority as an *ex officio* member. The Authority staff under the director of planning and research serves as the secretary to the Planning Coordination Committee.

So far as the Governors' request is concerned, the Authority has brought together for a common purpose a multiregional group which can effectively function as the forum in which the Tennessee-Tombigbee Waterway can be planned for in a cohesive, coordinated manner. What is basic to the Committee is that, though its members recognize that individual States and their units of government have responsibility for implementing plans for landside development of the waterway, a larger area, not confined to State boundaries, must work as a unit to fully develop the potential of the waterway, if that region is to capitalize on waterway potential. They have realized, also, that there can be a standardized approach without harming the established pattern of local self-determination.

The Authority sought and received a $75,000 planning grant from HUD to fund the activities of the Com-

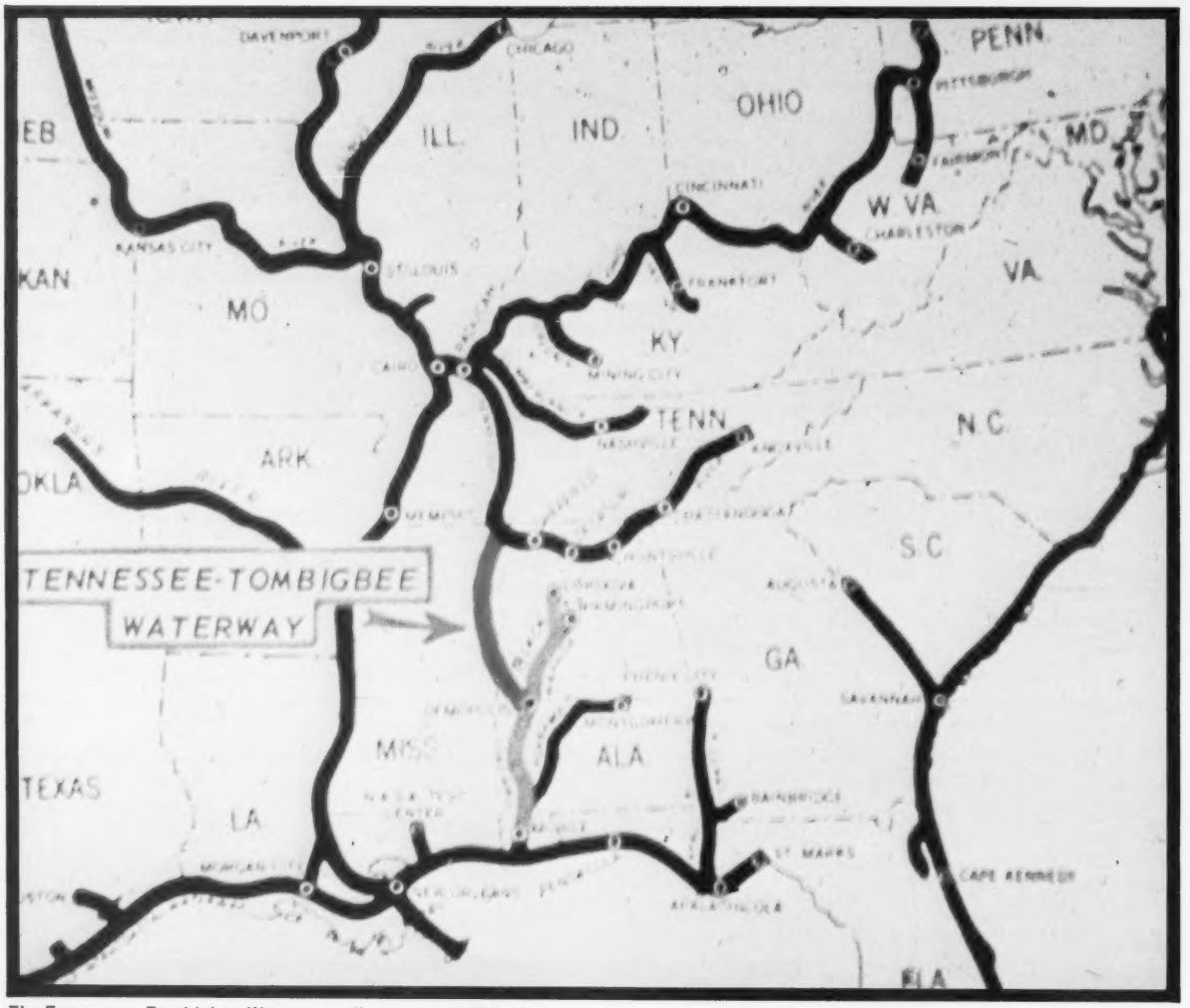
mittee for fiscal year 1975 and is continuing to provide assistance and support for development of a continuing annual work program for the States, through the Committee, to follow.

Where does it all lead? It is apparent that the compact States and the Authority have several choices which they can make. Obviously, one is to continue as they have been going and just as obvious, they can quit and go home. A better alternative would be to strengthen what has been accomplished thus far and make a concerted effort to work solidly together.

What has been accomplished then? Most importantly, the five States agreed that they could work together since they had a common goal . . . the landside development of the Tennessee-Tombigbee Waterway. Because of that agreement, the Committee has been formed and has met regularly since the formation.

The Committee has developed, in conjunction with the Appalachian Regional Commission (ARC) staff, a planning work program for areas within the Appalachian Region. As an outgrowth of that program, ARC has developed a proposal for an overall impact study of the Tennessee-Tombigbee Waterway on the 13 Appalachian States. Additional Federal funds have been found to include in the ARC study States not in the Appalachian Region but which are in the direct tributary area of the Tennessee-Tombigbee Waterway.

Committee agreement has been reached to begin in fiscal year 1976 an assessment of all planning and development activities directly related to the waterway. In the same assessment work will be undertaken to standardize mapping and other data which will be used by the compact States in planning and developing the waterway.

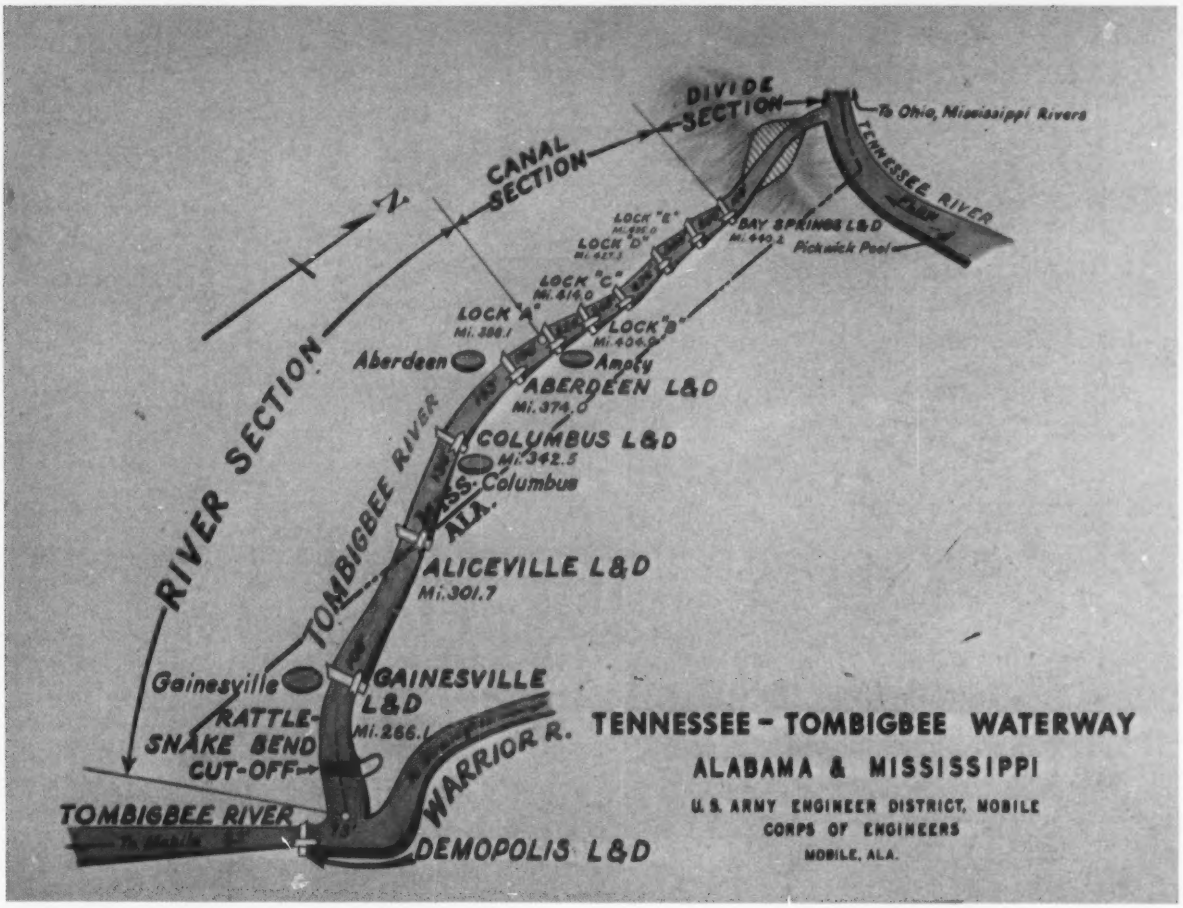


The Tennessee-Tombigbee Waterway will connect 16,000 miles of inland waterways to the port of Mobile, providing 23 States in mid-America a shorter route to the Gulf of Mexico.

The Authority has been instrumental in having passed by Congress a survey resolution indicating the need for establishment of a Corps of Engineers Urban Studies project on 22 counties adjacent to the waterway. Staff work has brought about the inclusion of the Mobile Bay Area into this study. The Mobile District Engineer staff has discussed with the Committee and Authority staff the need to use the Committee as the responsive group for the States included in the study, as well as coordinator in the other compact States. The Committee has agreed to be this vehicle during the course of the 4-year study. In addition, waterway impact economic analysis being carried out by the Mobile District and wildlife mitigation planning efforts by the Corps has been and will be coordinated with State and local planning by the Committee.

To an area having strong attachments to provincialism, the actions thus far taken by the Committee, though they be few, are no small accomplishment. But we still have to answer the question, "Where does it all lead?"

Of obvious importance is the contribution which Federal agencies can make toward the accomplishments of a coordinated plan for the waterway environs. It almost goes without saying that the individual States and the local units of government will not have the necessary resources to concentrate capital investment on the waterway. On a scale of development comparable to the investment for construction of the waterway, a coordinated effort to focus Federal multiregional investment on the waterway will have to be accomplished. One such approach which the Committee is now exploring is the possible development of a Federal Integrated Grant for planning and development activi-



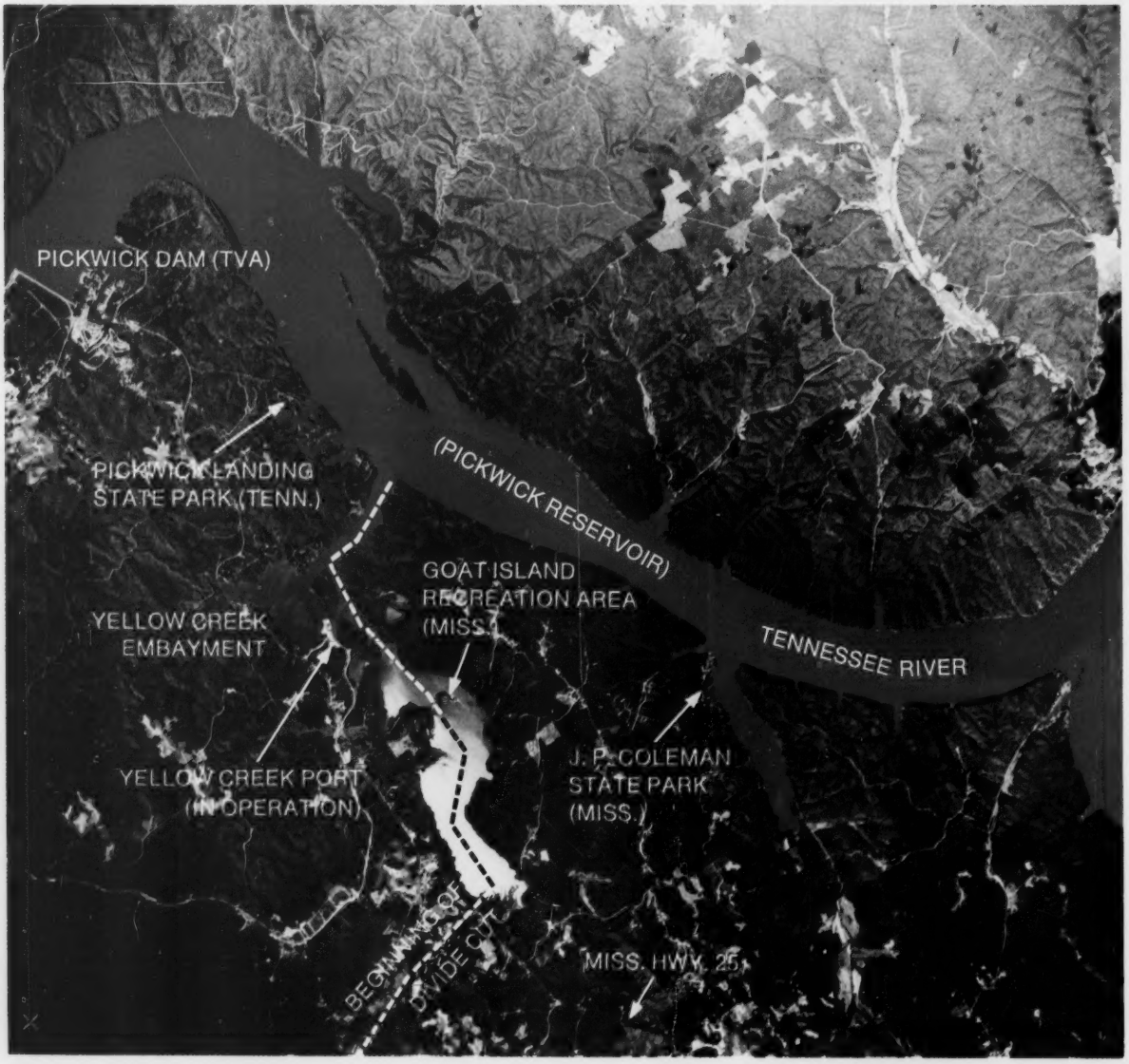
Engineering responsibility for the three construction sections of the 253-mile, ice-free waterway is divided between the Corps' Nashville and Mobile Districts.

ties within the waterway area. Plans have been made to work very closely with the Federal Regional Council in this regard also. The Authority and the Committee have also established new relationships with Federal agencies and congressional committees and their staffs in order to more adequately deal with the waterway challenges.

Private sector investment also must be coordinated to the greatest extent possible. Difficult though it may be, the job of encouraging controlled development by the private sector and including it in the overall planning package is essential. Staff work on behalf of the Committee, thus far, has been to determine, as well as possible, what potential investment packages are being considered and to act as an information and referral service.

State development agencies have, up to this point, been as closemouthed as they can to insure that an industry or major capital investment stays in their respective States. Be that as it may, the Committee hopes to coordinate major public sector investment and insure planning for it to help influence private sector investment as it takes place. The overriding consideration for this effort is obvious. The Committee must provide for a coordinated plan of action which will encourage Federal investment and Federal-State-local cooperation in order to have the primary planning activities of the States completed, as nearly as possible, before construction of the waterway is completed. The planning, coupled with the Federal investment packages, should have considerable influence on the private sector investment.

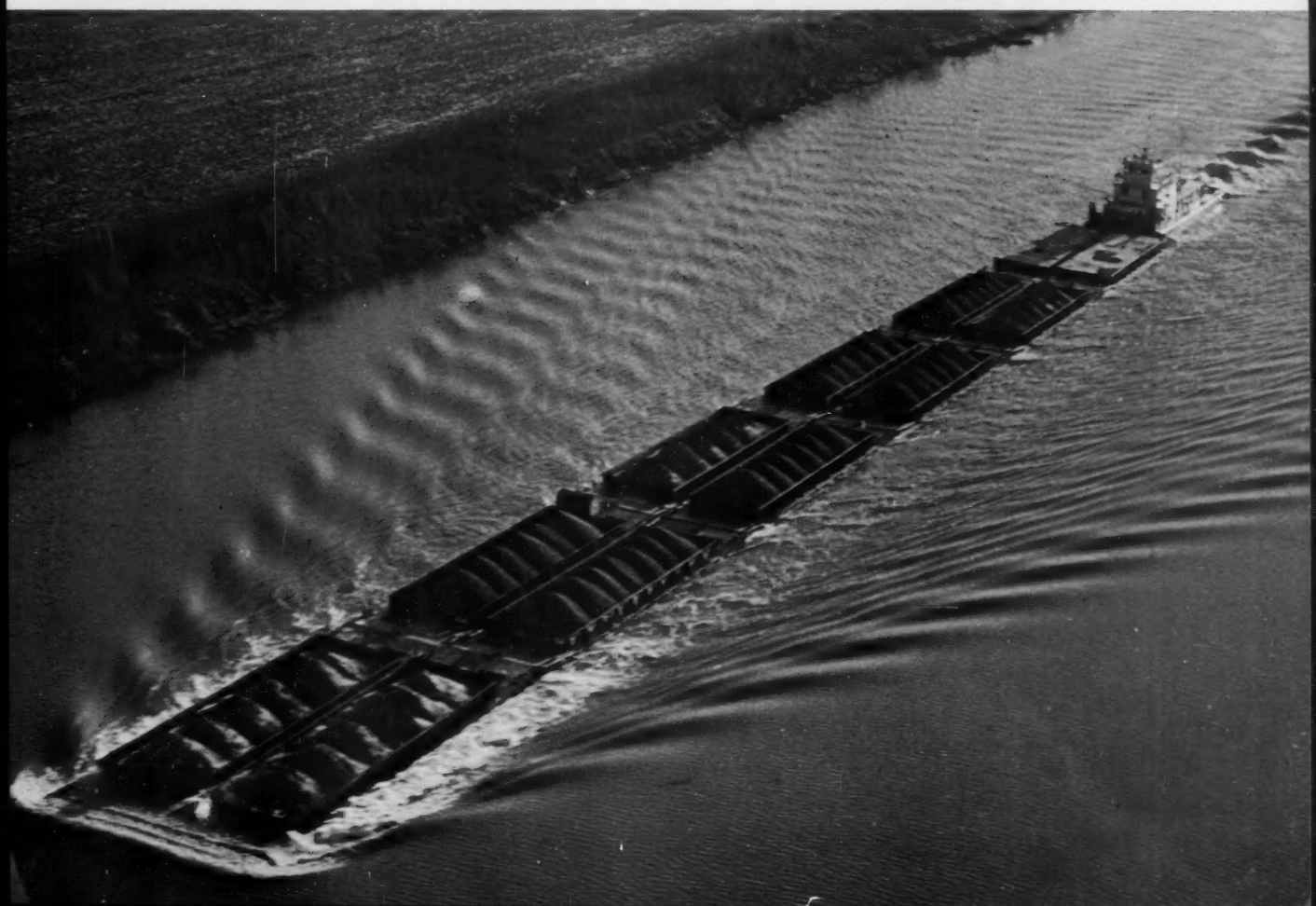
Divide cut will connect Tennessee-Tombigbee Waterway to Tennessee River at lower end of Yellow Creek embayment, which includes plans for development of a port (already operating) and several industrial sites. TVA's Pickwick Lock and Dam structure created embayment. NASA



Pickwick Lake, at northern terminus, illustrates the potential water-related recreation benefits the new waterway's 40,000 acres of lakes will bring to a previously land-locked area.

First of the 10 locks and five dams needed to overcome the 341-foot difference in elevation along the waterway's route is this half-completed structure taking form at Gainesville, Ala.

Low-cost transportation of western Kentucky coal to Florida steam plants is estimated to reach over a million tons upon completion of the Tennessee-Tombigbee Waterway.



Artist concept of the Aberdeen (Miss.) Lock and Dam, which will become the last one in the river section of the waterway.

Alabama has plans to modernize its port of Mobile to meet the increased needs of the future waterway.

A great deal has been said, thus far in this article, concerning controls and investments. The human resources aspects of planning are intertwined and therefore dependent on the land uses and investments along the waterway environs. The Authority and the Committee are deeply concerned about human resources and developing policies, plans and programs to insure this facet will be adequately addressed in our planning efforts. We are hopeful that the coordination effort will assure human resources and development are interfaced with each other.

The final outcome of the planning efforts of the Tennessee-Tombigbee Waterway Development Authority and the Planning Coordination Committee cannot readily be ascertained, since this effort is breaking fresh ground, so far as a large multistate effort is concerned, and far too little information is available to gauge the results. Myriads of agencies and public/private interest groups all have a stake in the final development of the waterway, yet only a small portion of these have an inkling of what may be the future of the waterway and its impacts.

Positive results which are demonstrable to the public remain unavailable for inspection since the Committee became operable such a short time ago. Simple things such as Committee rules of operation are still in the discussion stages and the first plan has yet to be drawn up.

However, there is evidence of a great deal of enthusiasm by the States. They have succeeded in sitting down and talking over the challenge which they face, and they are ready to begin working hand-in-hand toward the development of a blueprint to follow. They also have great hope that what they do may become an example of cooperation and coordination for other States to follow. They are not blinded, however, to the fact that they may have many failures before they succeed.

The five compact States have worked together diligently in making the Tennessee-Tombigbee Waterway project become a reality. Many fine men and women have dedicated themselves to see that construction would be started. Now that the project is underway, they have not forgotten that they must work even more closely together and much harder to insure the wise use of land around the waterway and to plan for the impacts before there is a mad rush to capitalize on the waterway and its benefits.

The Authority, in concert with the compact States, faces a real challenge in developing a coordinated approach to planning for the environs of the Tennessee-Tombigbee Waterway. A plan basic to the desires of the States collectively appears to be the best of alternatives. However, before the plan is developed the Authority, with and through the Planning Coordination Committee, needs to formalize the existing Federal-State, State-to-State, State-substate, and substate-to-local structures on a multiregional basis in order to fully implement landside planning and development in a coordinated and cooperative manner.

Recognizing a problem is often more difficult than solving it once it has been identified. Since it appears that hurdle to successful planning has already been surmounted, the Authority and the Committee is now ready to pursue the quest for, not just a model of planning excellence, but a working solution that will benefit future generations. ■

by Hugh H. Hudson
Staff Hydrologist
U.S. Geological Survey

Water for Wyoming's Coal

Plans to convert this country's enormous coal reserves into alternate forms of energy all require large amounts of water. The problem is that so much of these deposits lie under some of our more arid regions. Of the Nation's approximately 3.2 trillion tons, 40 percent is in the area covered by western North Dakota, eastern Montana and northeastern Wyoming. An estimated 110 billion tons lie under northeastern Wyoming alone.

In terms of coal, the latter region is roughly 20,000 square miles extending into six counties stretching from the Big Horn Mountains on the west to the Black Hills on the east and nearly as far south as Casper. The bulk of the region's major strippable coal deposits are contained within Campbell County. In fact, Campbell County is reputed to have more coal than any other county in the United States.

Gillette, the county seat and area metropolis, saw its population double between 1960 and 1970 after two recent oil booms hit an area that had been primarily cattle country for years. The area outside Gillette is still sparsely populated, with less than two residents per square mile. Gillette itself now has 8,000 residents. Even though a recently installed desalinization plant utilizing an electrodialysis process can produce 1.5 million gallons per day, this is sufficient for no more than 11,000 residents, while Gillette's population is expected to double again by 1980. Gillette shares boomtown problems of water supply, housing, schools, sewage treatment and other modern society requirements with other towns in the region faced with a massive influx of new residents.

The magnitude of coal development and its impact on this area is revealed in the estimate that annual coal production for power plants and other current uses will double by the end of 1977 and then double again by 1980. For the State as a whole, annual production may be as much as 100 million tons by 1980. If only the most probable forecast materializes, Wyoming coal companies will mine twice as much coal in the 13 years between 1973 and 1985 as the State produced in the previous 108 years of documented coal production. Much of this will occur in northeastern Wyoming, and it is likely that Campbell County will be in the forefront of the activity.

While coal mining requires very little water, coal processing of the types that characterize industry's plans for this region has an enormous thirst. It is one of nature's ironies that these rich coal deposits occur in an area that is water deficient, but require water for their conversion to other energy forms. The average annual precipitation in most of northeastern Wyoming is about 12 inches, with extreme variations from year to year and from place to place. The maximum precipitation occurs along the western edge in the Big Horn Mountains, where approximately 40 inches fall each year, and in the Black Hills on the eastern border, where about 30 inches of precipitation occur each year.

Most streams in the immediate vicinity of the coal deposits flow only after rains or snowmelt periods and are therefore dry during most of the year. The major streams of northeastern Wyoming are the Powder, Tongue, Cheyenne, Little Missouri, and the Belle Fourche Rivers. The North Platte River drains the extreme southern part. Their tributaries, except for those that originate in the Big Horn Mountains or Black Hills, are generally dry. Most are interstate compact streams; that is, the flows are apportioned between Wyoming and adjacent States in accordance with legal agreements.

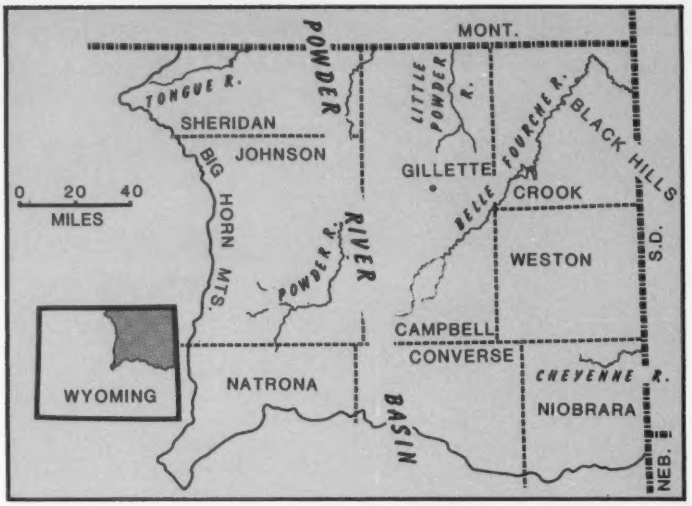
Let us look now at the estimates of water needs for coal development and the types of use that are directly associated with coal processing.

Figures 1 and 2 show the water requirements for coal production and other uses within the Powder River Basin and the likely sources of these supplies. These are shown together because the water supplies are regional, will be developed for the most part on a regional basis, and no single area should be examined without looking at the larger picture.

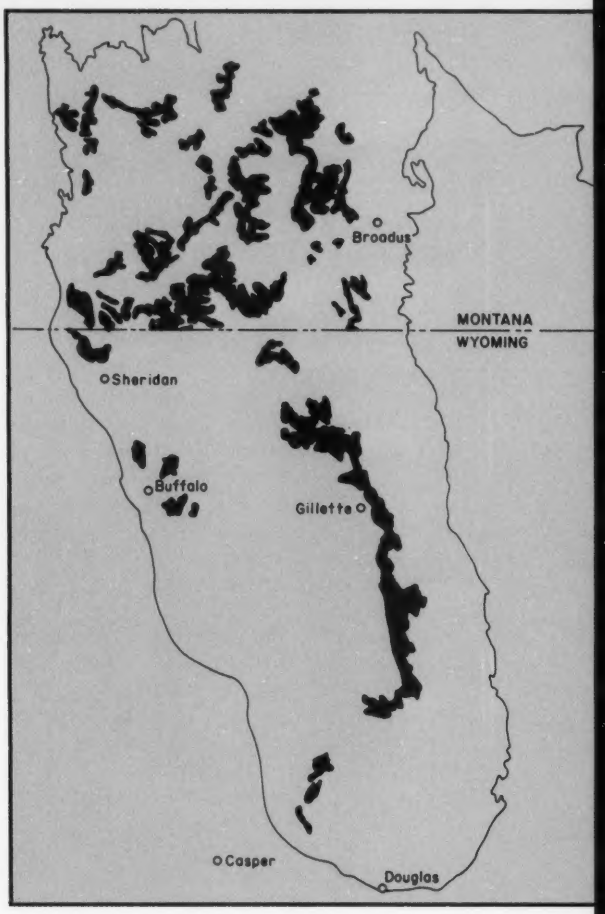
Existing and planned industries within northeastern Wyoming that use water consumptively include coal-fired electric generating plants, production of synthetic fuels, and transportation of coal as slurry in pipelines to other States. For all practical purposes, water estimated for these uses is entirely *consumed*; essentially none will be returned as streamflow or as ground-water recharge.

Water for cooling thermal-electric power plants constitutes one of the largest blocks of water requirements. In fact, nationwide, *withdrawals* of water for "wet-cooling" steam power generation exceed that withdrawn for irrigation. However the *consumption* of water for irrigation is much greater. Water requirements for cooling may be substantially reduced if "dry cooling" becomes a reality on a commercial scale.

This article is based on a presentation before the National Water Supply Improvement Association at Newport Beach, Calif., July 16, 1974.



Enormous coal deposits underlie northeastern Wyoming.



Right—Known strippable coal deposits in the Powder River basin have made Gillette, seat of Campbell County, into a boom town.

"Dry cooling" operates on the same principal as an automobile radiator. The water is circulated through a complex of exposed pipes, and much of the heat of the water is transferred to the air. According to an article in the May 1974 issue of *Coal Age*[1], a 330-megawatt air-cooled plant planned for construction near Gillette has water requirements estimated at one-hundredth of those for a water-cooled power plant of similar size.

Synthetic fuel plants loom large in northeastern Wyoming's future. By 1980, two gasification plants are expected to be on line and, by 1985, five such plants may be in operation. These will be "first-generation" plants and the initial projections of water required by each one have been estimated at nearly 30,000 acre-feet per year. Longer-range planning assumes development of more efficient conversion processes, with a resultant drop to between 5,000 and 15,000 acre-feet per plant.

Although shipment of coal by slurry pipeline is really not new, the magnitude and water requirements of this type of coal transportation from northeastern Wyoming are worthy of a special note. Wyoming has approved plans for a coal-slurry pipeline that will move 25 million tons per year from Campbell County to a terminal in Arkansas via a 38-inch pipe. The project, at an estimated cost of $2 billion, has a maximum water allocation of 20,000 acre-feet per year, although this much may not be required.

Only rough estimates can be made of the water requirements of the coal industry in northeastern Wyoming. Absolute, total amounts that may be needed are uncertain in the face of improved technologies, a reduction of coal needs by possible new oil discoveries, the vagaries of foreign oil sources, and market prices of the products. In addition, no one can accurately estimate total water requirements for revegetation and rehabilitation, because such efforts have never been attempted on a large scale under the climatic and soil conditions that prevail in northeastern Wyoming.

Still, estimates of water needs must be made, and they exceed by far the known available supplies in this part of the State. As of 2 years ago, the U.S. Bureau of Reclamation had received requests for about 700,000 acre-feet of water per year to be delivered to Campbell County alone.

Where does one look to obtain large, new supplies? Diversion of streamflows that are excess to local and downstream users obviously deserves serious attention, and is being appraised on a reconnaissance level by the Bureau of Reclamation. In its April 1972 "Appraisal Report on Montana-Wyoming Aqueducts," the Bureau of Reclamation described a system of aqueducts that could be constructed to deliver large quantities of water to northeastern Wyoming. Their studies were based on an estimated annual need for about 2.6 million acre-feet in less than 30 years in the coal areas of northeastern Wyoming and eastern Montana. Coal fields and conversion plants in eight counties in both States would be the terminal points of water delivery.

Three of the proposals to import water into northeastern Wyoming involve diversions from the Yellowstone River system. One proposed system would transport water from Boysen Reservoir on the Big Horn River to Gillette via a 182-mile-long pipeline. The system would deliver 135,000 acre-feet per year at an

[1] G. B. Glass, "Wyoming: Production Seen Doubling by 1976," *Coal Age*, May 1974, Vol. 79, No. 5, pp 96-107.

Analysis of core sample being prepared for shipment may indicate coal producing potential of this drilling site on Montana-Wyoming line, but availability of water for processing may be key to developing this resource. Bureau of Reclamation

Steam generating plant east of Gillette, Wyo., adjoins mine site where coal deposits lie under less than 24 feet of overburden. Arid nature of area may require import of water to process coal into other energy forms. Bureau of Reclamation

estimated $250 per acre-foot. This and the following dollar estimates are based on 1974 costs.

Further downstream on the Yellowstone River proper, a diversion is under consideration that would require a 180-mile pipeline from Hardin, Mont., to Gillette. The delivery price per acre-foot at Gillette would be about $220, and the system would provide 312,000 acre-feet annually to northeastern Wyoming.

Even further downstream on the Yellowstone is another possible diversion site at Miles City, Mont. A 173-mile aqueduct would be required to deliver water to the Gillette vicinity. The acre-foot cost of water near Gillette would be about $220 for 382,000 acre-feet per year.

Even though Yellowstone River water is available in large quantities, the picture is clouded by a provision of the compact between Montana, Wyoming and North Dakota that prohibits export of Yellowstone River water to points outside its own basin without permission of all three signatory States. Although the compact can be changed, or all the States concerned could agree to this transbasin diversion, neither of these options is yet a fact.

Another alternative would be to pump water from either the Oahe or Garrison Reservoirs on the main stem of the Missouri River to the Northern Great Plains coal fields. Although this alternative would not affect that provision of the compact, costs would be considerably higher for delivered water. Current estimates are about $285 per acre-foot delivered to the coal fields. Reversing the procedure, the coal could be transported to the Yellowstone Basin, but again, costs would be high.

Still another source of water involves the Green River, a tributary to the Colorado River. Wyoming is not using its entire allotment of Upper Colorado Basin water as provided by the Colorado River Compact. As a part of its study of streamflow diversions to meet coal needs in northeastern Wyoming, the Bureau of Reclamation has suggested the Green as a possible source. The Bureau's preliminary estimates are approximately $240 per acre-foot for the 239,000 acre-feet per year that could be delivered to northeastern Wyoming.

The aqueduct system or any of its major components would require the construction of additional reservoirs. Although the operation of the reservoirs would maintain minimum in-stream requirements for fish and wildlife—and therefore enhance the aquatic environmental aspects—their construction would inundate bottom lands and wildlife habitat. Therefore such construction is not expected to go unchallenged by those who feel the land forms of environmental damage may outweigh the gains.

Alternative surface-water supplies being considered by Wyoming are the State's unused and unappropriated shares of Tongue, Powder, North Platte, and Cheyenne River waters. Estimates show that about 260,000 acre-feet per year may be available to Wyoming from these sources. However, the flows are extremely variable, particularly in the Powder and Tongue Rivers, and some storage capacity would be required in order to develop dependable supplies.

Consider now another source of water that is everywhere silent and unseen—ground water. I will somewhat arbitrarily divide the aquifers into two groups:—the upper aquifers, which include the al-

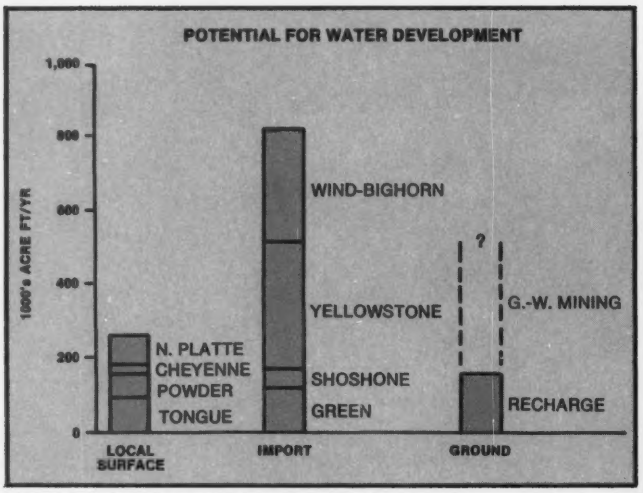


Figure 1. Potential sources for water development in the Powder River basin.

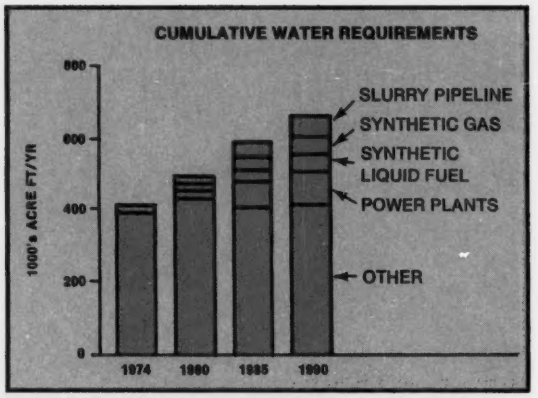


Figure 2. Cumulative water requirements for Powder River basin's coal production and other uses.

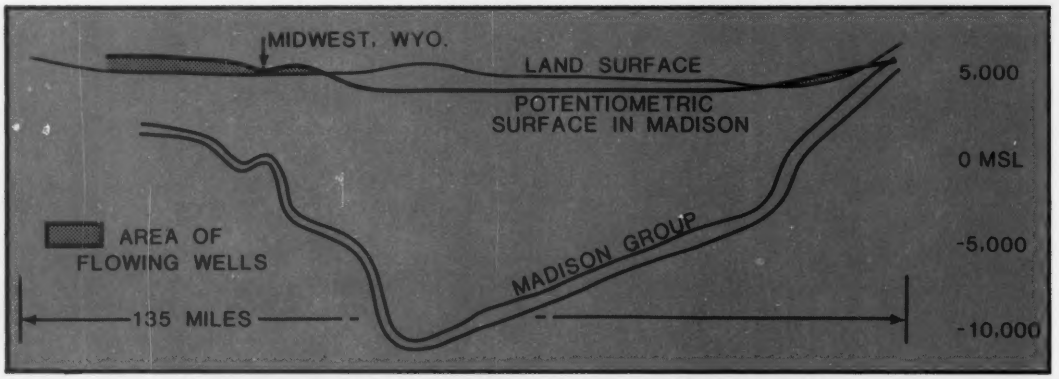
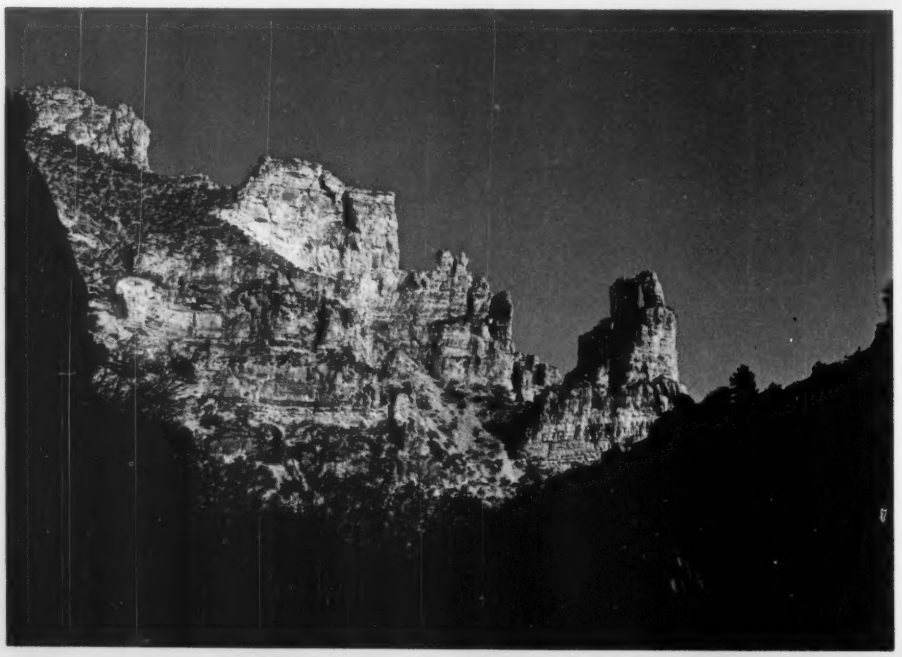
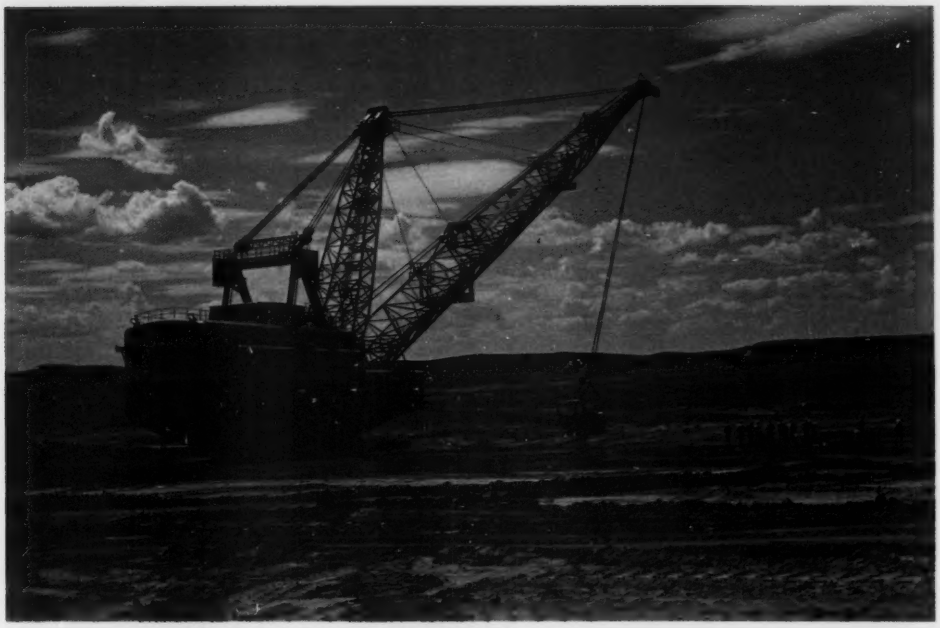


Figure 3. Large quantities of ground water may exist in Madison Group of rocks, which underlies entire Powder River basin area of Wyoming and Montana.



Outcrop of Madison Limestone is visible above ground in ground water recharge area of Big Horn Mountains, Wyo.



Monster 45-yard dragline shovel hints at massive scope of mining operations envisioned for this area of Wyoming.

luvium and underlying formations down to and including the Fox Hills Sandstone; and the deep aquifers, of which the most important on a regional basis is the Madison Group. Above the Madison and associated rocks, except at the extreme eastern and western edges, is a thick sequence of impermeable rocks—mostly shales—which have little or no potential as aquifers. They are important, though, as partial barriers to upward leakage of water from the Madison.

The upper aquifers have for years been extremely important sources of domestic, municipal, and stock water. Their importance as local, relatively small, sources will undoubtedly increase as the population density increases in northeastern Wyoming and associated light or service industry develops. On the basis of information from wells that penetrate these upper aquifers, it is unlikely that they will yield sufficient water of satisfactory quality to satisfy the large scale requirements of coal conversion plants. The quality of the water is generally poor and fair at best. Treatment costs for the most part would be high for uses requiring high quality water.

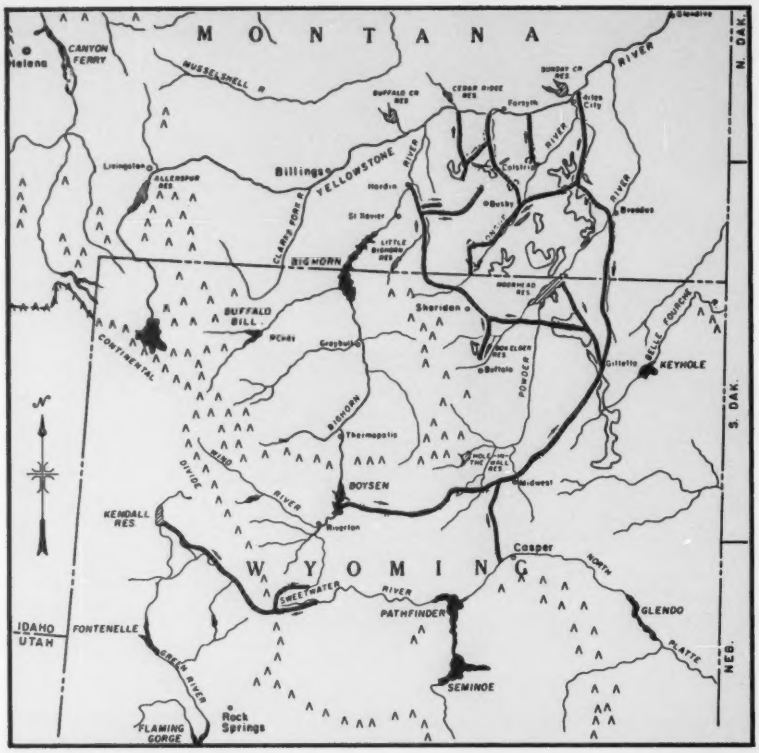
An enormous quantity of ground water is available within a thousand feet of the surface in the Powder River drainage basin of northeastern Wyoming. By estimate, about 85,000,000 acre-feet of water in the Wasatch and Fort Union Formations are available to wells. The quality, however, is generally poor, and treatment costs have been estimated at nearly $180 per acre-foot and total product costs at $358 per acre-foot.

On the basis of the limited information available, the Madison Limestone sequence offers one of nature's *good news-bad news* stories. Leading the list of good points is the sheer enormity of the Madison Group of rocks. It underlies the entire Powder River Basin and extends northward beneath the coal regions of Montana. The thickness of the Madison is about 200 feet near the south end of the basin, about 800 feet near the Wyoming-Montana State line, and increases to about 1,400 feet near the Yellowstone River. The associated carbonates, which are in hydraulic continuity with the Madison, are from 50 to 200 feet thick. The areal extent and thickness of these rocks, coupled with the possibility that solution openings and fracturing are extensive, offer a favorable chance that extremely large quantities of water may exist and may be recoverable.

On the bad news side is the extreme depth that a well would have to be drilled to penetrate the Madison, except near the outcrop areas. Note from figure 3 that the land surface at the center of the basin is more than 4,000 feet above sea level, and the top of the Madison Limestone is about 10,000 feet below sea level. It is the depth and the correspondingly high cost of test drilling that has prevented any systematic exploration and testing of the deeper reaches of the Madison. True, oil exploration data exist; but in cases where the water data are obtained somewhat incidentally to the major objective of test drilling for oil or gas, the results, at best, are hydrologically limited and certainly discontinuous in terms of a regional water assessment.

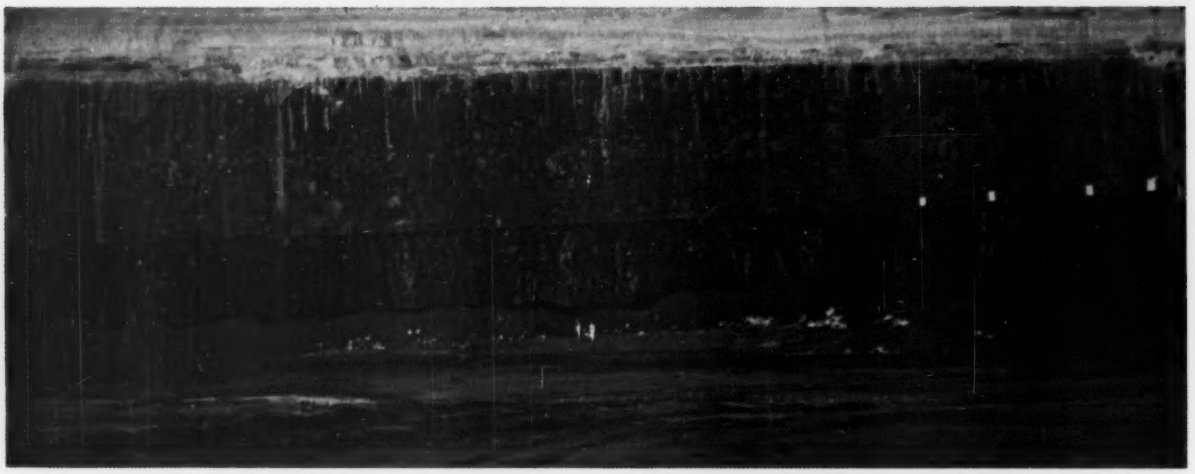
There may be other problems in developing this water in large quantities. Recharge in northeastern Wyoming is estimated to be about 100,000 acre-feet per year, and most enters where streams cross the outcrop near the Black Hills on the east and in the Big Horn Mountains to the west. Some recharge is rejected and returns to the surface as springs. It is estimated conservatively that 70,000 to 80,000 acre-feet may be produced annually from the Madison without affecting existing wells, particularly near the eastern and western boundaries of the basin. It is from this source that the State has authorized a maximum of 20,000 acre-feet per year to supply the previously mentioned slurry pipeline.

The quality of water from the Madison Group is



Four possible routes have been studied for construction of aqueducts that could deliver surface water from the Yellowstone or Green Rivers into northeastern Wyoming.

Below—Approximately 100-foot thick coal seam at northeastern Wyoming mine dwarfs two men standing at its base and supplies low-sulfur coal to steam generating plants in area.



good near the recharge areas but generally deteriorates toward the center of the basin and the northern edge of the aquifer, except for local anomalies such as the Bell Creek oil field near Broadus, Mont. Not only will drilling and well construction costs be high in much of the area underlain by the Madison, but the quality is such that in certain areas treatment may be expensive. Based on samples from three wells between 5,000 to 7,500 feet deep in Wyoming's Natrona and Johnson Counties estimates of treatment costs range from zero to $186 per acre-foot. Estimated costs of water from the Madison (treated, if necessary) delivered to sites near Gillette and Buffalo are $111 to $479 per acre-foot. The Madison Group needs additional study before it should be considered as other than an interim, supplemental source of water for the large quantities required by the coal industry. Such a study is now getting underway.

Estimates of water supplies to meet large scale coal requirements in northeastern Wyoming, whether catalogued by sources or by amounts, are at present uncertain. Today's projections are subject to tomorrow's legislation, markets, and technologies. Long considered the black sheep of the energy family, coal is coming into a new era of its own; but its water requirements will add a new stress upon established patterns of water use in northeastern Wyoming. ■

Events, Deeds & Deliberations

Notes From The Log of The *Sergeant Floyd*

Launched at Howard Shipyards, Jeffersonville, Ind., May 31, 1932.

Purchased by the United States Government for the U.S. Army Corps of Engineers.

Mission: Tow and survey duties on the inland waterways under the jurisdiction of the Missouri River Division, Corps of Engineers.

The towboat was named in memory of Sergeant Charles Floyd, an Engineer soldier who accompanied Lewis and Clark on their famous journey to the Pacific Northwest in 1804. The only fatality on that expedition, he is believed to be the first American soldier to die in the newly purchased Louisiana Territory. The site of his burial is now called Floyd's Bluff and is a part of the Municipal Park of Sioux City, Iowa.

The vessel is powered by two 600-horsepower diesel engines which drive twin screw propellers. She has a steel hull and a wooden superstructure. The draft, when loaded, is approximately 4 feet. The length of the hull is 138 feet and 5 inches, and the width of the beam is 30 feet and 9 inches. The *Sergeant Floyd* is capable of attaining a speed of approximately 11 knots in open water.

Operated by the Kansas City District, Missouri River Division, Corps of Engineers, the *Sergeant Floyd* was a primary workhorse in the construction of the Missouri River Navigation Projects. Used to move men, equipment and supplies along the river and as the primary Corps towboat, she became a familiar sight along the Missouri. As the Missouri River Projects neared completion and as newer equipment became available, her work role diminished and she was on the verge of decommissioning when she was selected, and authorized by the Congress, for a final, historic task: a floating, bicentennnial exhibit for the U.S. Army Corps of Engineers.

This historic task began at St. Louis in June 1975, when the *Sergeant Floyd* shoved off for 18 months of plying the inland waterways and the Gulf section of the Intracoastal Waterway, bringing to thousands of Americans the story of the Corps of Engineers' contributions to the development of our country. ■

Bicentennial Theater Program

The U.S. Army Corps of Engineers Bicentennial celebration will reach water recreation oriented Americans beginning this summer when an open-air amphitheater will be operated at many Corps lakes where overnight camping areas are under Corps supervision.

Bicentennial related programs will be presented on a regular basis throughout the 1975 and 1976 recreation seasons. In addition to Bicentennial films, the programs will also include movies on such subjects as water safety, environmental protection and others of interest to the recreation public.

There will be no charge to the public for these showings.

Flood Plain Management Film

Development and use of the flood plains has become a growing concern of the Corps of Engineers. In order to inform the public of the advantages of flood plain management, the Corps has developed a movie entitled, "Perils and Possibilities: The Need for Flood Plain Management." The film is available for showing from the Corps' division and district offices.

The movie describes many dangers and opportunities related to the development and use of our flood plains. Included are a wide variety of conditions which result from inappropriate uses and development and their related costs.

Coliform Confusion

Coliform bacteria counts may no longer be our traditional indicators of sewage contamination of water. It used to be said that the more bacteria present, the worse the pollution. However, Frank R. Peabody and Walter L. Mallman, microbiologists at Michigan State University, have discovered that these organisms, previously thought to exist only in human intestines, can also live and reproduce outside the human body. These findings have been presented to the American Society for Microbiology.

Historic Site Losing Ground

Faced with the possible loss of one of Alaska's historic landmarks—the Native Cemetery—the Division of Parks of the Alaska Department of Natural Resources has asked the Corps' Alaska District for help.

The cemetery, located at Dyea, is slowly being eaten away by the waters of the Taija River. In 1918 the cemetery was 800 feet from the river, and in 1973 it was found that the grave nearest the river was separated from the water by a mere 200 feet. The district has been asked to make a survey report on the erosion problem and help determine how to save the landmark.

Dredging Saves Fort

Fort Massachusetts, located 12 miles off the Mississippi Gulf Coast on Ship Island, is an example of how dredged material can be put to good use. The island was slowly eroding away from the fort, and as a result, the fort became an island in itself.

The National Park Service (NPS) acquired the island and the fort as part of the Gulf Islands National Seashore and, wanting to protect the fort from further damage, it requested the Corps' Mobile District to

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consider placing dredged material around the fort. The district agreed to the NPS request because it was the best disposal alternative for the dredged material and added sociological and economic benefits.

The district first constructed a low dike to prevent the dredged material from spreading into an adjacent marsh. Then, in March 1974, 500,000 cubic yards of sandy material, dredged from the nearby navigation channel, was placed around the fort.

Because of the success of this operation, and the continued need to dredge the navigation channel, the Corps is considering periodic placement of sand around this historic fort.

Flood Plain Booklet

The hazards of building on the flood plain and suggestions for how to avoid them are the subject of a booklet entitled, "Flood Plain—Handle With Care," (EP 1105-2-4) published by the Corps of Engineers. The booklet is available free from the OCE Publications Depot, 890 South Pickett Street, Alexandria, Va. 22304.

The experiences of concerned citizens in one watershed in coping with the flood hazard are traced in the booklet. Their experience suggests how other communities can get started in this important element of planning. The booklet includes lists of options available to communities to reduce flooding, services available from the Corps of Engineers and other Federal agencies, and a sample application letter for a Flood Plain Information Study.

Three-in-Two Dedication

Completion of the Corps' four structures along Washington's Snake River was marked in grand style as a fleet of boats sailed upstream to three different dam sites in 2 days for three separate dedication ceremonies. Completion of this project opened up the twin cities of Clarkston, Wash.-Lewiston, Idaho to the ports of the world by tieing in 140 miles of the Lower Snake River to the Columbia River which is navigable to the Pacific Ocean.

The last three dams in the Snake River chain were dedicated on the morning and afternoon of June 18 and the following morning of June 19. In order of dedication, they were the Lower Monumental, Little Goose and Lower Granite Locks and Dams. The triple dedication ceremonies concluded on June 20 with an extensive program at Lewiston, Idaho. The first of the four structures completed was Ice Harbor Lock and Dam, which impounded the downstream Snake River Canyon's slack water.

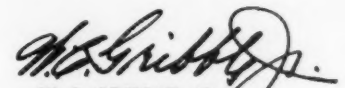
In addition to the year-around navigation feature, the four-dam project provides 1.5 million kilowatts of power initially as well as recreation, irrigation and flood damage prevention benefits.

Continued from inside front cover.

Pacific. In Korea and Viet Nam the ratio was as high or even higher. Construction—of training camps, munitions plants, airfields, depots and ports—is the first decisive step in modern mobilization. In 1940 and 1941, the Corps civil works organization took over a mushrooming defense build-up when the Quartermaster Construction Division, geared to slender peacetime military budgets, proved unequal to the task. By mid-1942, construction was going into place at the rate of $20 million per day. In a five-year period, the Corps completed homefront military projects costing approximately $13.7 billion (roughly $50 billion at 1970 prices), plus the $2 billion Manhattan District program for development of the atomic bomb. Subsequent mobilizations for the Korean and Viet Nam struggles, big by pre-1940 standards, proceeded swiftly and well. In the strange arena of the Cold War, Corps construction strength made possible airfields and missile bases to contain the Communist Powers and multiplex projects to aid the development of friendly nations.

General Robert J. L. Pinson, Chief of Engineers, French Army, said in 1948: "The word 'miracle' has often been used when reporting the exploits of the American Corps of Engineers during the last war. . . . In fact, there has been no miracle, . . . there has been only the logical result of a peacetime engineer organization unique in the world, which participates actively . . . in the development and execution of great public works of National interest."

Thus, in our Bicentennial year, it is a time to reflect on the past, but most important, to carefully consider the future. While it is essential that the Corps continues to maintain its national defense posture, it is also equally as critical that our water resources development and management missions be carried on with all of the foresight that we can muster because the big problems are yet to come. We must dedicate our national will, our strength and our intelligence to their resolution to insure that there will still be a future when coming generations celebrate our Nation's Tricentennial.



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Cypress swamp typifies a natural resource Florida seeks to protect as a critical area of concern. See page 26.